



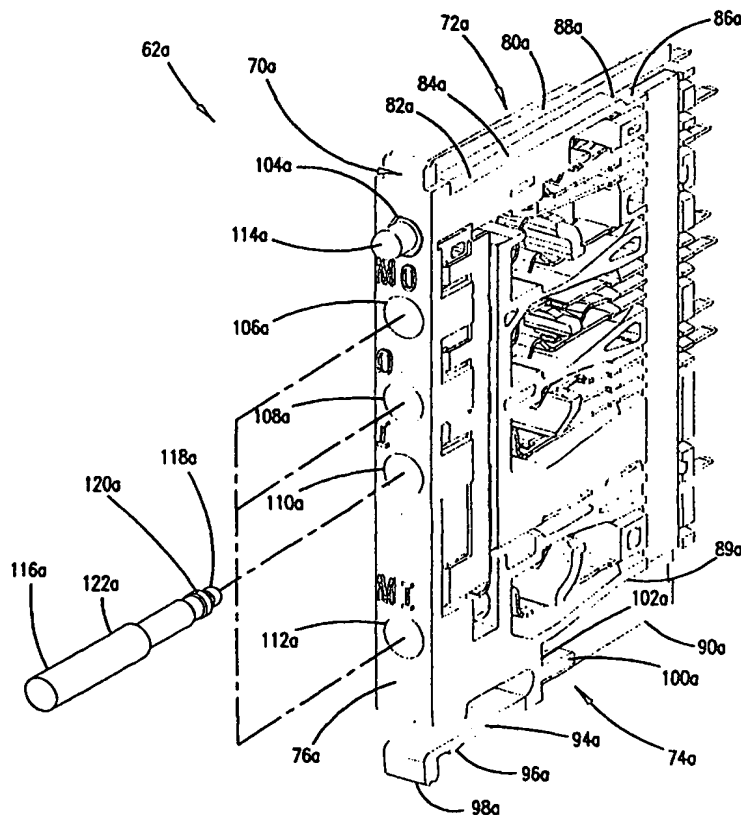
## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(54) Title: JACK ASSEMBLY

## (57) Abstract

The invention relates to a jack assembly including a jack mount with a jack receiving region. A jack is adapted to be slidably mounted in the jack receiving region. The jack includes a jack body formed of a dielectric material and a plurality of electrically conductive tip and ring springs. The jack body defines a plurality of bores sized to receive plugs having tip and ring contacts. The jack assembly further includes a plurality of cross-connect contacts and a rear interface assembly including a dielectric support. A plurality of rear connectors project outward from the dielectric support, and a circuit board is positioned between the jack mount and the dielectric support. The circuit board provides connections between the cross-connect contacts and the normal contacts. An electrical interface between the jack and the circuit board is configured such that when the jack is removed from the jack mount, the jack is automatically disconnected from the circuit board.



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## JACK ASSEMBLY

### Field of the Invention

5 The present invention relates generally to cross-connect assemblies and, in particular, to jack assemblies for digital cross-connect systems.

### Background of the Invention

10 A digital cross-connect system (DSX) provides a location for interconnecting two digital transmission paths. The apparatus for a DSX is located in one or more frames, or bays, usually in a telephone central office. The DSX apparatus also provides jack access to the transmission paths.

15 DSX jacks are well known and typically include a plurality of bores sized for receiving tip-and-ring plugs. A plurality of spring contacts are provided within the bores for contacting the tip-and-ring plugs. The jacks are typically electrically connected to digital transmission lines, and are also electrically connected to a plurality of wire termination members used to cross-connect the jacks. By inserting plugs within the bores of the jacks, signals transmitted through the jacks can be interrupted or monitored.

### 20 Summary of the Invention

One aspect of the present invention relates to a jack assembly including a jack mount having a front side and a rear side. The jack mount has top and bottom supports defining a jack receiving region that opens outward toward the front side of the jack mount. A jack of the assembly is adapted to be slidably mounted in the jack receiving region defined between the top and bottom supports of the jack mount. The jack includes a jack body formed of a dielectric material, and a plurality of electrically conductive tip and ring springs. The jack body defines a plurality of bores sized to receive plugs having tip and ring contacts. The tip springs are adapted to make electrical contact with the tip contacts of the plugs when the plugs are inserted within the bores, and the ring springs are adapted to make electrical contact with the ring contacts of the plugs when the plugs are inserted within the bores. When plugs are not mounted within the bores, the tip and ring springs make electrical contact with normal contacts mounted within the jack. The jack assembly also includes a plurality of cross-connect contacts, and a rear interface assembly. The rear interface assembly includes a dielectric support having a first side that faces the jack mount and a second side that faces away from the jack mount. A plurality of rear connectors project outward from the second side of the dielectric support, and a circuit board is positioned between the jack mount and the

dielectric support. The circuit board is configured to provide electrical connections between the rear connectors and the tip and ring springs. The circuit board also is configured to provide electrical connections between the cross-connect contacts and the normal contacts. The jack assembly further includes a resilient retaining member  
5 connected to one of the jack and the jack mount for securing the jack within the jack mount. The resilient retaining member is moveable between a first position in which the retaining member is adapted to retain the jack within the jack mount, and a second position in which the jack can be inserted into or removed from the jack mount. An electrical interface between the jack and the circuit board is configured  
10 such that when the jack is removed from the jack mount, the jack is electrically disconnected from the circuit board.

Another aspect of the present invention relates to a jack assembly including a jack mount having a front side and a rear side. A jack is positioned at the front side of the jack mount. The jack includes a jack body formed from a  
15 dielectric material. The jack body defines a plurality of bores each sized to receive a plug having a tip contact and a ring contact. The jack also includes a plurality of electrically conductive tip-and-ring springs. The tip springs are adapted to make electrical contact with the tip contacts of the plugs when the plugs are inserted within the bores, and the ring springs are adapted to make electrical contact with the  
20 ring contacts of the plugs when the plugs are inserted within the bores. The jack further includes a plurality of normal contacts adapted to normally make electrical contact with the tip-and-ring springs. A plurality of cross-connect contacts are electrically connected to the normal contacts of the jack. The jack assembly also includes first and second rear interface assemblies that can selectively be secured  
25 adjacent to the rear side of the jack mount. The first rear interface assembly includes a plurality of wire termination members that are electrically connected to the tip-and-ring springs when the first rear interface assembly is secured to the jack mount. The second rear interface assembly includes a plurality of coaxial connectors. The coaxial connectors are electrically connected to baluns that are electrically connected  
30 to the tip-and-ring springs when the second rear interface assembly is secured to the jack mount. The first and second rear interface assemblies allow a single common universal jack mount to interface either with standard twisted pair signal lines, or coaxial signal lines.

A further aspect of the present invention relates to a jack assembly  
35 including a jack mount having a front side and a rear side, and a jack positioned at the front side of the jack mount. The jack includes a jack body formed of a dielectric material. The jack body defines a plurality of bores each sized to receive a plug having a tip contact and a ring contact. The jack also includes a plurality of

electrically conductive tip and ring springs. The tip springs are adapted to make electrical contact with the tip contacts of the plugs when the plugs are inserted within the bores, and the ring springs are adapted to make electrical contact with the ring contacts of the plugs when the plugs are inserted within the bores. The jacks  
5 further include a plurality of normal contacts adapted to normally make electrical contact with the tip-and-ring springs. A plurality of cross-connect contacts are electrically connected to the normal contacts of the jack. A rear interface assembly is positioned at the rear side of the jack mount. The rear interface assembly includes a dielectric support having a first side that faces the jack mount and a second side  
10 that faces away from the jack mount. The rear interface assembly further includes a plurality of baluns supported by the dielectric support, and a plurality of coaxial connectors that project outward from the second side of the support and are electrically connected to the baluns. Contact members, that are electrically connected to the baluns, project outward from the first side of the support. The  
15 contact members provide an electrical connection between the baluns and a circuit board. The circuit board provides electrical connections between the contact members and the tip and ring springs of the jack, and also provides electrical connections between the cross-connect contacts and the normal contacts of the jack.

A variety of advantages of the invention will be set forth in part in the  
20 description that follows, and in part will be apparent from the description, or may be learned by practicing the invention. It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the invention as claimed.

#### 25 Brief Description of the Drawings

The accompanying drawings, which are incorporated in and constitute a part of the description, illustrate several aspects of the invention and together with the description, serve to explain the principles of the invention. A brief description of the drawings is as follows:

30 FIG. 1 is an exploded view of a chassis constructed in accordance with the principles of the present invention;

FIG. 2 is a front perspective view of a jack in accordance with the principles of the present invention;

FIG. 3 is a rear perspective view of the jack of FIG 2;

35 FIG. 4 is a side view of the jack of FIG. 2;

FIG. 5 is a front perspective view of an another jack in accordance with the principles of the present invention;

FIG. 6 is a rear perspective view of the jack of FIG 5;

- FIG. 7 is a side view of the jack of FIG. 5;
- FIG. 8 is a front perspective view of jack mount in accordance with the principles of the present invention;
- FIG. 9 is a front view of a portion of the jack mount of FIG. 8;
- 5        FIG. 10 is a cross-sectional view taken along section line 10-10 of FIG. 9;
- FIG. 11 is a cross-sectional view taken along section line 11-11 of FIG. 9;
- FIG. 12 is a rear perspective view of the jack mount of FIG. 8;
- 10       FIG. 13 is a rear view of the jack mount of FIG. 8;
- FIG. 14 is an assembly view of the jack mount of FIG. 8;
- FIG. 15 is a front exploded view of a jack mount and twisted pair rear interface assembly in accordance with the principles of the present invention;
- 15       FIG. 16 is a rear exploded view of the jack mount and twisted pair rear interface assembly of FIG. 15;
- FIG. 17 is a side assembled view of the jack mount and twisted pair rear interface assembly of FIG. 15;
- FIG. 18 is a schematic circuit diagram corresponding to the jack mount and twisted pair rear interface assembly of FIG. 15;
- 20       FIG. 19 is a front exploded view of a jack mount and coaxial rear interface assembly in accordance with the principles of the present invention;
- FIG. 20 is a rear perspective view of the coaxial rear interface assembly of FIG 19;
- FIG. 21 is an exploded view of a connector constructed in accordance with the principles of the present invention;
- 25       FIG. 22 is an assembled side view of the connector of FIG. 21;
- FIG. 23 is a cross-sectional view taken along section line 23-23 of FIG. 22;
- FIG. 24 is an exploded view of another connector constructed in accordance with the principles of the present invention;
- 30       FIG. 25 is an assembled side view of the connector of FIG. 24;
- FIG. 26 is a cross-sectional view taken along section line 26-26 of FIG. 25;
- FIG. 27 is an exploded view of the coaxial rear interface assembly of FIG. 20;
- 35       FIG. 28 is a rear view of the coaxial rear interface assembly of FIG. 20;
- FIG. 29 is an enlarged view of a portion of FIG. 28; and

FIG. 30 is an enlarged view of another portion of FIG. 28.

### Detailed Description

Reference will now be made in detail to exemplary aspects of the present invention which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

#### I. Chassis assembly

Figure 1 is an exploded view of an embodiment of a chassis 20 for housing a plurality of jack mounts 22. For clarity, only two jack mounts 22 are shown in figure 1. However, it will be appreciated that the chassis 20 is adapted for housing a plurality of jack mounts 22. To conform with conventional international standards, the chassis 20 can house 16 jack mounts 22 and have a length of about 19 inches. Alternatively, in accordance with standard United States specifications, the chassis could be configured to house 21 jacks and have a length of about 23 inches. Of course, other sizes and numbers of jack mounts could also be used.

The chassis 20 includes a top piece 24 positioned opposite from a bottom piece 26. The top and bottom pieces 24 and 26 are interconnected by left and right side walls 28 and 30. The chassis 20 also includes a front side 32 positioned opposite from a back side 34. The top piece 24 includes separate front and back components 23 and 25. The front component 23 is connected to the chassis 20 by fasteners (e.g., screws) that extend through a front lip 27 of the front component 23 and engage front tabs 29 provided on the side walls 28 and 30. The rear component 25 is connected to the chassis 20 by fasteners (e.g., screws) that extend downward through top tabs 31 provided on the side walls 28 and 30. The rear component 25 defines a recessed lip 35 for receiving a rear portion of the front component 23 to form a joint thereinbetween. The removable front component 23 assists in inserting or removing the jack mounts 22 into or from the chassis 20.

A wire tray door 36 is connected to the bottom piece 26 adjacent the front side 32 of the housing 20. A hinge 37 allows the door 36 to pivot between horizontal and vertical orientations. Latches 39 hold the door 36 in the vertical orientation. Additionally, a rear flange 38 projects upward from the bottom piece 26 adjacent the back side 34 of the chassis 20. The rear flange 38 defines a plurality of notches or cutaway portions 40. A plurality of mounting flanges 42 project upward from the bottom piece 26 between the front and back sides 32 and 34 of the chassis 20. The mounting flanges 42 are adapted for connecting the jack mounts 22 to the chassis 20. For example, the mounting flanges 42 are shown including holes for allowing the jack mounts 22 to be screwed or bolted to the mounting flanges 42.

The mounting flanges 42 define cutaway portions 44 that correspond to alternating ones of the cutaway portions 40 defined by the rear flange 38.

Cover members 46 are positioned between the mounting flanges 42 and the rear flange 38. The cover members 46 define recesses 48 that align with the cutaway portions 40 and 44 respectively defined by the rear flange 38 and the mounting flanges 42. The cover members 46 function to conceal screws or other types of connecting members used to connect the jack mounts 22 to the mounting flanges 42. When coaxial rear interfaces (described later in the specification) are used in combination with the jack mounts 22, the cutaway portions 40 and 44 and the recesses 48 provide clearance for allowing the coaxial connectors to be accessed. In this manner, the height of the chassis 20 can be minimized while still providing access to the lowermost coaxial connectors.

The chassis 20 also includes a cover plate 50 connected below the top piece 24 of the chassis 20. A power strip 52 is connected to the front cover plate 50. The power strip 52 includes a plurality of electrical receptacles 54 electrically connected to a main power connector 56. The receptacles 54 align with and are set behind alignment openings 58 defined by the cover plate 50.

As shown in figure 1, the jack mount 22 is part of a jack assembly including odd jacks 62a, even jacks 62b, and a rear interface assembly 64. The rear interface assembly 64 includes a dielectric support 66, and a circuit board 68 positioned between the dielectric support 66 and the jack mount 22. The odd and even jacks 62a and 62b preferably have different configurations such that when the jacks 62a and 62b are mounted within the jack mount 22, plug bores defined by the jacks 62a and 62b are vertically staggered relative to one another.

## II. Odd Jack Configuration

Figures 2-4 illustrate one of the odd jacks 62a in isolation from the jack mount 22. The jack 62a includes a dielectric jack body 70a. The dielectric jack body 70a includes a top side 72a and a bottom side 74a arranged and configured to slidably interface with the jack mount 22. The jack body 70a also includes a front side 76a positioned opposite from a back side 78a. The top side 72a of the jack body 70a includes an elongated guide member 80a that extends between the front and back sides 76a and 78a of the jack body 70a. As best shown in figure 3, the guide member 80a tapers laterally outward as it extends from the back side 78a toward the front side 76a. Guide surfaces 82a are positioned on opposite sides of the guide member 80a. The guide surfaces 82a include substantially parallel front and rear portions 84a and 86a. The front and rear portions 84a and 86a are interconnected by ramped portions 88a such that the front portions 84a are elevated relative to the rear portions 86a.



The bottom side 74a of the jack body 70a includes a guide member 90a that extends between the back side 78a of the jack body 70a and a transverse wall 92a. The guide member 90a tapers laterally outward as it extends from the back side 78a toward the transverse wall 92a. The transverse wall 92a forms a base end of a cantilevered locking member 94a that extends from the transverse wall 92a toward the front side 76a of the jack body 70a. A locking tab 96a projects downward from the locking member 94a. A gripping member 98a projects downward from a free end of the locking member 94a. The locking member 94a preferably has a resilient or elastic structure such that the locking member 94a can be flexed upward by pressing upward on the gripping member 98a. By flexing the locking member 94a, the locking member 94a can be moved between a retaining position  $P_{a1}$  (shown in Figure 4) and a non-retaining position  $P_{a2}$ .

The bottom side 74a additionally includes alignment members 100a that project laterally outward from opposite sides of the guide member 90a. The alignment members 100a are also connected to the transverse wall 92a and at least partially define alignment notches 102a positioned above the alignment members 100a. Guide surfaces 89a are positioned above notches 102a and include front and rear portions 91a and 93a interconnected by a ramped portion 95a. The rear portions 93a are elevated relative to the front portions 91a.

As best shown in figure 2, the front side 76a of the jack body 70a is generally planar and defines a light emitting diode (LED) port 104a, a monitor out port 106a, an out port 108a, an in port 110a, and a monitor in port 112a. The LED port 104a is sized for receiving an LED 114a. Each of the other bores 106a, 108a, 110a and 112a is sized to receive a standard tip-and-ring plug 116a of known dimensions. The plug 116a includes a tip contact 118a, a ring contact 120a and a cylindrical sleeve 122a.

As shown in figure 3, the back side 78a of the jack body 70a is formed by a generally planar surface 124a that is generally parallel with respect to the front side 76a. The planar back surface 124a defines a plurality of back slots 126a each having a generally rectangular shape.

Referring now to figure 4, the jack body 70a also defines a monitor out chamber 128a, an out chamber 130a positioned below the monitor out chamber 128a, an in chamber 132a positioned below the out chamber 130a, and a monitor in chamber 134a positioned below the in chamber 132a.

The monitor out chamber 128a is in communication with both the LED port 104a and the monitor out port 106a. The LED 114a is mounted within the LED port 104a and includes first and second leads 136a and 138a that project into the monitor out chamber 128a. The first lead 136a is contacted by an electrically

conductive voltage spring 141a, and the second lead 138a contacts an electrically  
conductive tracer lamp spring 142a. Electrically conductive tip-and-ring springs  
145a and 144a are positioned within the monitor out chamber 128a in general  
alignment with the monitor out port 106a. The ring spring 144a and the tip spring  
5 145a are separated by a dielectric spacer 182a that is integrally formed with the jack  
body 70a. A LED return spring 143a is positioned between the ring spring 144a and  
the tracer lamp spring 142a. When the tip-and-ring plug 116 is inserted within the  
monitor out port 106a, the ring spring 144a is flexed upwardly while the tip spring  
145a is flexed downwardly. The ring spring 144a contacts the ring contact 120a,  
10 and the tip spring 145a contacts the tip contact 118a of the plug 116a. When the ring  
spring 144a is flexed upward, it causes the LED return spring 143a to contact the  
second lead 138a of the LED 114a thereby illuminating the LED 114a. A dielectric  
pad 184a attached to the ring spring 144a prevents the ring spring 144a from  
electrically contacting the LED return spring 143a.

15 The out chamber 130a is in communication with the out port 108a.  
Electrically conductive tip-and-ring springs 149a and 146a are positioned within the  
out chamber 130a in general alignment with the out port 108a. The tip-and-ring  
springs 149a and 146a are normally in electrical contact with the respective  
electrically conductive normal springs 148a and 147a. The normal springs 147a and  
20 148a are separated by a dielectric spacer 184a that is integrally formed with the jack  
body 70a. When the plug 116a is inserted within the out port 108a, ring spring 146a  
is disconnected from normal spring 147a and electrically contacts the ring contact  
120a of the plug 116a. Concurrently, tip spring 149a is disconnected from normal  
spring 148a and electrically contacts the tip contact 118a of the plug 116a.

25 The in chamber 132a is in communication with the in port 110a.  
Electrically conductive tip-and-ring springs 150a and 153a are positioned within the  
in chamber 132a in general alignment with the in port 110a. The tip-and-ring  
springs 150a and 153a are normally in electrical contact with respective electrically  
conductive normal springs 151a and 152a. Normal springs 151a and 152a are  
30 separated by a dielectric spacer 186a that is integrally formed with the jack body  
70a. When the plug 116a is inserted within the in port 110a, the tip-and-ring springs  
150a and 153a are respectively disengaged from the normal springs 151a and 152a,  
and respectively make electrical contact with the tip-and-ring contacts 118a and  
120a of the plug 116a.

35 An electrically conductive sleeve ground spring 154a is positioned  
between the in chamber 132a and the monitor in chamber 134a. The ground spring  
154a is electrically connected to a grounding strip 188a that has electrical contacts  
corresponding to each of the ports 106a, 108a, 110a and 112a. The contacts are

configured to engage the sleeve 122a of the plug 116a when the plug is inserted within the ports 106a, 108a, 110a and 112a.

The monitor in chamber 134a of the jack body 70a is in communication with the monitor in port 112a. Electrically conductive tip-and-ring springs 155a and 156a are positioned within the monitor in chamber 134a in general alignment with the monitor in port 112a. A dielectric spacer 190a is positioned between the tip-and-ring springs 155a and 156a. When the plug 116a is inserted within the monitor in port 112a, the tip spring 155a makes electrical contact with the tip contact 118a and the ring spring 156a makes electrical contact with the ring contact 120a.

Referring to Figure 4, the springs 141a-156a are preferably held within the jack body 70a by a dielectric strip 191a. The dielectric strip 191a is preferably press-fit or snapped within a corresponding slot defined by the jack body 70a.

As best shown in figure 3, electrically conductive springs 141a-156a each include portions 141a'-156a' that extend through the slots 126a defined by the back side 78a of the jack body 70a. The portions 141a'-156a' project outward from the back side 78a and form generally flat contact members adapted for electrically connecting the springs 141a-156a to a desired structure. As shown in Figure 4, the portions 141a'-156a' have projection lengths that vary such that the tips of the portions 141a'-156a' are staggered. The staggered tips reduce the insertion force required to connect the jack 62a to a desired structure because all of the tips do not engage the desired structure simultaneously upon insertion.

### III. Even Jack Configuration

Figures 5-7 illustrate one of the even jacks 62b in isolation from the jack mount 22. The jack 62b includes a dielectric jack body 70b having a top side 72b positioned opposite from a bottom side 74b, and a front side 76b positioned opposite from a back side 78b. The top side 72b includes a laterally tapered guide member 90b, and a resilient locking member 94b having an upwardly projecting locking tab 96b. The locking member 94b can be flexed between a retaining position  $P_{b1}$  and a non-retaining position  $P_{b2}$ . A transverse wall 92b is positioned generally between the locking member 94b and the guide member 90b. Alignment notches 102b are formed generally below the transverse wall 92b on opposite sides of the guide member 90b. Guide surfaces 89b are positioned below the notches 102b on opposite sides of the guide member 90b. The guide surfaces 89b include front portions 91b elevated relative to rear portions 93b, and ramped portions 95b positioned between the front and rear portions 91b and 93b.

The bottom side 74b of the jack body 70b includes an elongated guide member 80b extending between the front and back sides 76b and 78b. The guide member 80b tapers laterally outward as it extends from the back side 78b toward the front side 76b. The bottom side 74b also includes guide surfaces 82b  
5 positioned on opposite sides of the guide member 80b. The guide surfaces 82b include substantially parallel front and back portions 84b and 86b. A ramped portion 88b interconnects the front and back portions 84b and 86b such that the back portions 86b are elevated relative to the front portions 84b.

It will be appreciated that the top and bottom sides 72b and 74b of the  
10 jack body 70b have different configurations than the top and bottom sides 72a and 74a of the jack body 70a. Preferably, the top and bottom sides of the jack bodies 70a and 70b have varying configurations in order to provide a keying function. For example, by varying the configurations of the top and bottom sides of the jack  
15 bodies 70a and 70b, a user is prevented from placing the jacks 62a and 62b in the wrong positions on the jack mount 22. The user is also inhibited from inserting the jacks 62a and 62b upside-down into the jack mount 22.

As shown in Figure 5, the front side 76b of the jack body 70b defines an LED port 104b, a monitor out port 106b, an out port 108b, an in port 110b, and a monitor in port 112b. It will be appreciated that the ports 104b, 106b, 108b, 110b  
20 and 112b are arranged in a different pattern than the ports 104a, 106a, 108a, 110a and 112a. For example, a larger spacing exists between the monitor out port 106b and the out port 108b as compared to the monitor out port 106a and the out port 108a. Additionally, a reduced spacing exists between the in port 110b and the monitor in port 112b as compared to the in port 110a and the monitor in port 112a.  
25 It will be appreciated that the terms "port" and "bore" are intended to be used interchangeably.

The jack 62b has similar internal components to those previously described with respect to the jack 62a. For example, the jack 62b includes an LED 114b electrically connected to a voltage spring 141b and a tracer lamp spring 142b  
30 by leads 136b and 138b. An LED ground spring 143b is used to complete the circuit and light the LED 114b. The jack 62b also includes tip-and-ring springs 145b and 144b corresponding to the monitor out port 106b, tip-and-ring springs 149b and 146b corresponding to the out port 108b, tip and ring springs 150b and 153b corresponding to the in port 110b and tip-and-ring springs 155b and 156b  
35 corresponding to the monitor in port 112b. The ring-and-tip springs 146b and 149b normally contact respective normal springs 147b and 148b, and tip-and-ring springs 150b and 153b normally contact respective normal springs 151b and 152b. The jack 62b also includes a sleeve ground spring 154b interconnected to a grounding strip

188b having sleeve contacts corresponding to each of the ports 106b, 108b, 110b and 112b. The conductive springs 141b-156b each include end portions 141b'-156b' (best shown in figure 6) that project outward from the back side 78b of the jack body 70b so as to form electrical contact members. As shown in Figure 7, the tips of the  
5 end portions 141a'-156a' are staggered.

#### IV. The Jack Mount

Referring now to figure 8, the jack mount 22 is shown in isolation from the chassis 20 with the jacks 62a and 62b removed. Generally, the jack mount 22 includes a mounting body 200 made of a dielectric material. The mounting body  
10 200 includes a jack receiving piece 202 that can be detachably connected to a cross-connect piece 204. As will be described in greater detail below, the jack receiving piece 202 is adapted for housing or holding the jacks 62a and 62b, while the cross-connect piece 204 is adapted for providing cross-connects between jacks.

The jack receiving piece 202 of the mounting body 200 includes a  
15 front side 206 positioned opposite from a back side 208. The piece 202 also includes spaced-apart and substantially parallel top and bottom supports 210 and 212 that extend generally between the front and back sides 206 and 208. The top and bottom supports 210 and 212 are interconnected by a back wall 214 of the jack receiving piece 202. The top support 210, the bottom support 212 and the back wall  
20 214 cooperate to define a jack mounting region or recess that opens outward toward the front side 206 of the upper piece 202.

As shown in figure 9, the jack receiving piece 202 of the mounting body 200 defines four separate jack mounting locations  $ML_1$ ,  $ML_2$ ,  $ML_3$  and  $ML_4$ . Jack mounting locations  $ML_1$  and  $ML_3$  are adapted to receive the odd jacks 62a,  
25 while mounting locations  $ML_2$  and  $ML_4$  are adapted for receiving the even jacks 62b.

Mounting locations  $ML_1$  and  $ML_3$  each include top and bottom channels 224 and 226 respectively formed on the top support 210 and the bottom support 212. The top and bottom channels 224 and 226 are configured to respectively complement the top and bottom sides 72a and 74a of the jacks 62a. For  
30 example, referring to figure 10, the top channels 224 are tapered so as to compliment or match the taper of the guide members 80a formed on the top sides 72a of the jack bodies 70a. Additionally, the walls forming the top channels 224 have downwardly facing guide surfaces 228 including front portions 230, rear portions 232 and ramped portions 234 that respectively correspond to and complement the front portions 84a,  
35 rear portions 86a and ramped portions 88a of the guide surfaces 82a positioned along the top side 72a of the jack body 70a.

As shown in figure 11, the bottom channels 226 are tapered so as to complement or correspond to the taper of the guide member 90a positioned at the

bottom side 74a of the jack body 70a. The bottom channels 226 also include end projections 236 adapted to mate with or fit within the alignment notches 102a formed adjacent the bottom side 74a of the jack body 70a. The walls forming the channels 226 have upwardly facing guide surfaces 223 including front, rear and  
5      ramped portions 225, 227 and 229 that respectively complement the front, rear, and ramped portions 91a, 93a and 95a of the guide surfaces 89a formed on the bottom side of each jack 62a.

            The jack 62a is mounted within one of the mounting locations  $ML_1$  and  $ML_3$  by inserting the rear ends of the guide members 80a and 90a respectively  
10      within the top and bottom channels 224 and 226. The jack 62a is then pushed inward toward the back wall 214 of the jack receiving piece 202 causing the guide members 80a and 90a to respectively slide along the top and bottom channels 224 and 226. When the jack 62a has been fully inserted into the jack receiving piece 202, the locking tab 96a of the resilient locking member 94a snaps within a hole 238  
15      (shown in figure 11) defined by the bottom support 212. To remove the jack 62a from the jack mount 22, the resilient locking member 94a is flexed from the retaining position  $P_{a1}$  to the non-retaining position  $P_{a2}$  such that the locking tab 96a is displaced from the hole 238. The jack 62a can then be manually pulled out from the jack receiving piece 202.

            Jack mounting locations  $ML_2$  and  $ML_4$  each define top and bottom channels 240 and 242 respectively formed on the top support 210 and the bottom support 212. The top channels 240 are configured to complement the shape of the top side 72b of the jack 62b. For example, the top channels 240 are tapered so as to complement the taper of the guide member 90b formed on the top side 72b of the  
20      jack 62b. As shown in Figure 10, the top channels 240 also include projections 244 adapted to fit within the alignment notches 102b formed on the jack body 70b adjacent the top side 72b. Furthermore, the walls defining the top channel 240 include downwardly facing guide surfaces 246 including front portions 248, rear portions 250 and ramped portions 252 that respectively complement the front, rear  
25      and ramped portions 91b, 93b and 95b of the guide surfaces 89b formed on the top side 72b of the jack body 70b. It is further noted that the top support 210 defines openings 254 arranged and configured to receive the locking tab 96b of the jack body 70b when the jack 62b is mounted within the jack mount 22.

            The bottom channels 242 are each configured to compliment the  
30      bottom side 74b of the jack body 70b. For example, as shown in figure 11, the bottom channels 242 are tapered to correspond with the taper of the guide member 80b formed on the bottom side 74b of the jack body 70b. Additionally, the walls defining the bottom channels 242 include guide surfaces 256 having front, rear and

ramped portions 258, 260 and 262 arranged and configured to respectively complement the front, rear and ramped portions 84b, 86b and 88b of the guide surfaces 82b formed on the bottom side 74b of the jack body 70b.

The top and bottom channels 224, 226 of mounting locations  $ML_1$  and  $ML_3$ , and the top and bottom channels 240, 242 of mounting locations  $ML_2$  and  $ML_4$  have been designed in coordination with the top and bottom sides of the jacks 62a and 62b in order to provide a keying function. For example, the jack 62a can only be mounted in the jack mount 22 if it is oriented in an upright position and is inserted into either one of the jack mounting locations  $ML_1$  and  $ML_3$ . Interference between the top and bottom sides of the jack 62a and the top and bottom channels 240 and 242 prevents the jack 62a from being inserted into either one of mounting locations  $ML_2$  and  $ML_4$ . Similarly, the even jack 62b can only be mounted at mounting locations  $ML_2$  and  $ML_4$ . If the user attempts to insert the jack 62b into either of the jack mounting locations  $ML_1$  and  $ML_3$ , the jack 62b will bind with the top and bottom channels 224 and 226 thereby preventing the jack 62b from being fully inserted into the jack mount 22.

As shown in figure 9, mounting locations  $ML_1$  and  $ML_3$  each include a corresponding pattern or array of openings 264 defined through the back wall 214 of the jack receiving piece 202 of the mounting body 200. The openings 264 are configured to receive the spring ends 141a'-156a' that project outward from the back side 78a of each jack 62a. Similarly, each of mounting locations  $ML_2$  and  $ML_4$  includes a corresponding pattern or array of openings 266 formed through the back wall 214 of the jack receiving piece 202 of the mounting body 200. The openings 266 are configured to receive the spring ends 141b'-156b' that project outward from the back side 78b of each jack 62b.

Referring to figure 12, the openings 264 and 266 extend completely through the back wall 214. Connection pins 268 are mounted within each of the openings 264 and 266. As shown in figure 14, each of the connection pins 268 includes a pin portion 270 that projects outward from the back side 208 of the jack receiving piece 202, and two opposing, cantilevered contact members 272 that are press fit within the openings 264 and 266. In the assembly view of figure 14, the connection pins 268 are shown connected to elongated installation tools 274 (e.g., the connection pins 268 and the installation tools 274 have been stamped from a common strip of conductive material). The installation tools 274 maintain a vertical spacing between the connection pins 268 that corresponds to the vertical spacing of the openings 264 and 266. For example, the installation tools 274 labeled A and B align the connection pins 268 in a pattern that corresponds to the pattern defined by the openings 264. The installation tools 274 labeled C and D align the connection

pins 268 in a pattern that corresponds to the pattern defined by the openings 266. The installation tools 274 are used to press multiple pins 268 in the openings 264 and 266 at once. After the pins have been pressed within the openings 264 and 266, the tools 274 are laterally twisted causing the pins to break-off within the openings  
5 264 and 266.

When the jacks 62a are mounted within the jack mount 22, the spring extensions 141a'-156a' fit within the openings 264 and are compressed between the opposing contact members 272 of the connection pins 268 such that the spring contacts 141a-156a are electrically connected to the pins 268. Similarly, when the  
10 jacks 62b are mounted within the jack mount 22, the spring extensions 141b'-156b' fit within the openings 266 and are compressed between the opposing contact members 272 of the connection pins 268 to provide an electrical interface between the jack springs 141b-156b and the connection pins 268. The variable lengths of the spring extensions 141a'-156a' and 141b'-156b' assist in reducing the insertion force  
15 required to press the spring extensions between the contact members 272.

Referring back to figure 8, the cross-connect piece 204 of the mounting body 200 is adapted for providing cross-connections between jacks. For example, four columns ( $C_1$ - $C_4$ ) and five rows ( $R_1$ - $R_5$ ) of wire termination members 276 (e.g., wire wrap members or posts) are shown projecting outward from a front  
20 face 278 of the piece 204. It will be appreciated that the removability of the cross-connect piece 204 from the jack receiving piece 202 is significant because different types of wire termination members or contacts can be used to provide cross-connections. For example, for certain applications, it may be desired to use insulation displacement connectors (IDC) for providing cross-connections between  
25 jacks. By using cross-connect pieces 204 that are separate from the jack mounting portion 202, cross-connect pieces having different types of connectors can be used with the common base to enhance manufacturing efficiency. While wire wrap members and insulation displacement connectors have been specifically described, it will be appreciated that other types of connectors could also be used.

To provide a detachable interface between the jack receiving piece 202 and the cross-connect piece 204, the cross-connect piece 204 includes two spaced-apart tongues 280 (shown in figure 8) that are slidably received within corresponding spaced-apart grooves 282 (shown in figure 13) defined by the jack receiving piece 202. To connect the cross-connect piece 204 to the jack-receiving  
30 piece 202, the tongues 280 are aligned with the grooves 282 and the cross-connect piece 204 is slid from the back side 208 of the jack receiving piece 202 toward the front side 206. The tongues 280 are slid along the grooves 282 until the front face 278 of the cross-connect piece 204 engages a shoulder 284 defined by the piece 202.  
35



When the cross-connect piece 204 engages the shoulder 284, an upwardly projecting tab 286 (shown in figure 8) formed on the cross-connect piece 204 snaps within a locking opening 288 (shown in figure 14) defined by a resilient clip 290 formed at the bottom of the jack receiving piece 202. To remove the cross-connect piece 204  
5 from the jack-receiving piece 202, the clip 290 is flexed upwardly such that the tab 286 disengages from the opening 288, and the lower piece 204 is pulled in a rearward direction from the upper body 202.

#### V. Twisted Pair Rear Interface

Figure 15 illustrates the dielectric support 66 of the rear interface  
10 assembly 64 removed from the circuit board 68. The dielectric support 66 includes a front side 300 adapted to face the circuit board 68, and a back side 302 adapted to face away from the circuit board 68. As shown in figure 16, the rear interface assembly 64 also includes four columns ( $C_a-C_d$ ) and four rows ( $R_a-R_d$ ) of wire termination members 304 press fit within holes defined by the dielectric support 66.  
15 The wire termination members 304 are shown as wire wrap members. However, it will be appreciated that other types of wire termination members such as insulation displacement connectors could also be used.

Referring to figure 16, the wire termination members 304 are adapted to contact plated through-holes 306 in the circuit board 68. Similarly, the wire  
20 termination members 276 of the jack mount 22 connect with plated through-holes 308 in the circuit board 68. The plated through-holes 306 are oriented in rows that are positioned between rows  $R_1-R_5$ . The circuit board 68 also includes a plurality of additional plated through-holes 310 positioned to make electrical contacts with the connector pins 268 that project outward from the back wall 214 of the jack mount  
25 upper piece 202 (shown in figure 12).

The dielectric support 66 of the rear interface assembly 64 defines a protective receptacle 318 in which a voltage lead 312, a return lead 314 and a sleeve ground lead 316 are mounted. The receptacle 318 is adapted to interconnect with the receptacles 54 formed on the power strip 52 of the chassis 20. When the jacks 62a  
30 and 62b are mounted within the jack mount 22, the voltage springs 141a, 141b of the jacks are placed in electrical connection with the voltage leads 312, the return spring 143a, 143b of the jacks 62a, 62b are placed in electrical connection with the return leads 314, and the ground springs 154a, 154b of the jacks 62a, 62b are placed in electrical connection with the shield ground leads 316.

35 Referring to figure 17, when the jack assembly 60 is assembled, the printed circuit board 68 is positioned between the jack mount 22 and the dielectric support 66 (the jacks of the assembly are not shown in Figure 17). The circuit board 68 includes a plurality of circuit paths for electrically connecting selected ones of the

connection pins 268 to the receptacle leads 312, 314 and 316, to the wire termination members 304 of the rear interface assembly 64, and to the cross-connect wire termination members 276. The single circuit board 68 is adapted for connecting all four jacks 62a and 62b (shown in figure 1) to the leads 312, 314 and 316, and to the  
5 their corresponding columns of rear interface wire termination members 304 and cross-connect wire termination members 276. When the jacks 62a and 62b are removed from the jack mount 22, the jacks 62a and 62b are disconnected from the circuit board 68.

As shown in figures 15 and 16, the circuit board 68, the jack mount  
10 22 and the dielectric support 66 define coaxially aligned openings sized to receive fasteners 69 (e.g., bolts or screws) for connecting the pieces together. The fasteners 69 extend through captivation washers 71 that are press-fit over the fasteners 69. The captivation washers 71 and the fasteners 69 hold the jack mount 22, the circuit board 68 and the dielectric support 66 together after assembly and inhibit the pieces  
15 from being unintentionally pulled apart prior to connection to the chassis 20. The assembly 60 is connected to the chassis 20 by threading the fasteners within holes defined by the chassis 20 (e.g., holes defined by the flanges 42 and the coverplate 50 of the chassis 20).

In use of the jack assembly 60, columns  $C_1$ - $C_4$  of cross-connect wire termination member 276 are respectively connected to jacks positioned in mounting locations  $ML_1$ - $ML_4$ . The wire termination members 276 of row  $R_1$  are tracer lamp contacts (TL), the wire termination members 276 of row  $R_2$  are cross-connect tip-out contacts (XTO), the wire termination members 276 of row  $R_3$  are cross-connect ring-out contacts (XRO), the wire termination members 276 of row  $R_4$  are cross-connect  
20 tip-in contacts (XTI), and the wire termination members 276 of row  $R_5$  are cross-connect ring-in contacts (XRI).

Columns  $C_a$ - $C_d$  of the IN/OUT termination members 304 are respectively in electrical contact with jacks inserted within jack mounting locations  $ML_1$ - $ML_4$ . The wire termination members 304 of row  $R_a$  are tip-out contacts (TO),  
30 the wire termination members 304 forming row  $R_b$  are ring-out contacts (RO), the wire termination members 304 forming row  $R_c$  are tip-in contacts (TI), and the wire termination members 304 forming row  $R_d$  are ring-in contacts (RI).

Figure 18 is a circuit diagram illustrating the electrical connections made when one of the jacks 62b is inserted within jack mounting location  $ML_4$ . It  
35 will be appreciated that similar electrical configurations are used to interconnect jacks placed in mounting locations  $ML_1$ - $ML_3$  with the corresponding columns of contacts  $C_1$ - $C_3$  and  $C_a$ - $C_c$ .

Referring to figure 18, the voltage spring 141b is electrically connected to an energized contact point (e.g., the voltage lead 312) for illuminating the LED. The tracer lamp spring 142b is connected to the tracer lamp contact TL of column C<sub>4</sub>. The return spring 143b is connected to the return lead 314. The shield ground spring 154b is connected to the shield ground lead 316. The out ring spring 146b is connected to the ring-out contact RO by circuit path 404. The ring normal spring 147b is connected to the cross-connect ring-out contact XRO of column C<sub>4</sub>. The tip normal spring 148b is connected to the cross-connect tip-out contact XTO of column C<sub>4</sub>. Tip spring 149b is connected to the tip-out contact TO of column C<sub>4</sub> by circuit path 406. The monitor out ring spring 144b is connected to circuit path 404, and the monitor out tip spring 145b is connected to circuit path 406. Tip spring 150b is connected to the tip-in contact TI of column C<sub>4</sub> by circuit path 408. Tip normal spring 151b is connected to the cross-connect tip-in contact XTI of column C<sub>4</sub>, and ring normal spring 152b is electrically connected to the cross-connect ring-in contact XRI of column C<sub>4</sub>. Ring spring 153b is connected to the ring-in RI contact of column C<sub>4</sub> by circuit path 410. Tip spring 155b is connected to circuit path 408, while ring spring 156b is connected to circuit path 410.

Cross-connection of a signal from another jack arrives as an IN signal from cross-connect tip-in and ring-in contacts XTI and XRI of column C<sub>4</sub>. With no plug inserted within the in port 110b, the IN signal is output at the tip-in and ring-in contacts TI and RI of column C<sub>4</sub>.

By inserting a plug within the in port 110b, the IN signal from a cross-connected jack can be interrupted and a signal from the inserted plug can be outputted at points TI and RI. Similarly, by inserting a plug within the out port 108b, the OUT signal from contact points TO and RO is interrupted and may be outputted to the tip-and-ring contacts of the plug inserted within the out port 108b.

Frequently it is desirable to be able to monitor OUT signals arriving through contacts TO and RO without interrupting the OUT signals. To accomplish this, a plug is inserted into the monitor port 106b. On this occurrence, the plug is able to tap into the OUT signals being transmitted through circuit paths 404 and 406. Additionally, when the plug is inserted into the port 106b, the return spring 143b is biased upward into contact with the second lead 138b of the tracer lamp 114b. The electrical connection between the second lead 138b and the return spring 143b connects the LED circuit to the return line 314 thereby illuminating the LED. Integrated circuit chip 184b controls flashing of the LED 114b as is conventionally known in the art. In addition to activating the LED, insertion of a plug into the monitor port 106b also grounds the tracer lamp line TL causing illumination of a LED on a jack to which the present jack is cross-connected.

At times it is also desired to be able to monitor signals on the IN line without interrupting the IN line signal. To accomplish this, a plug is inserted into the monitor in port 112b. When the plug is inserted into the port 112b, the plug taps into the in signal being transmitted through circuit path 408 between contacts XTI and TI, and circuit path 410 between contacts XRI and RI.

#### VI. Coaxial Rear Interface Assembly

Figure 19 illustrates a rear interface assembly 500 adapted to be secured to the jack mount 22. As shown in FIG. 20, the rear interface assembly 500 includes eight coaxial connectors 502. Four of the connectors 502 are IN connectors and four are OUT connectors. It will be appreciated that the rear interface assembly 500 and the rear interface assembly 64 are both compatible with or mountable on a common jack. Hence, the same jack can be used to manufacture jack assemblies suited for either twisted pair or coaxial type signals. By using common parts, manufacturing efficiency is enhanced.

Figures 21–23 illustrate one of the connectors 502. As shown in figure 23, the connector 502 is a type 1.6/5.6 connector and includes a grounded main body 512, a center conductor 514, and an insulator 517 mounted between the center conductor 514 and the main body 512. The main body includes a nut portion 516 having a generally hexagonal configuration. First and second threaded portions 518 and 520 are positioned on opposite sides of the nut portion 516. As best shown in figure 23, the main body also includes a pair of spaced-apart axial projections 522 that project axially from the main body 512. The first threaded portion 518 is positioned between the projections 522 and the nut portion 516, and the second threaded portion is adapted for connection to a coaxial connector. The axial projections 522 include notches 524 for facilitating terminating wires. The central conductor also projects outward the main body 512 at a location between the axial projections 522.

While a 1.6/5.6 type connector is shown, it will be appreciated that other types of coaxial connector could be used. For example, figures 24–26 show a BNC style connector 502' suitable for use with the rear interface assembly. The connector 502' includes a grounded main body 512', a center conductor 514', and a three-legged insulator 517' mounted between the center conductor 514' and the main body 512'. The main body includes a nut portion 516' having a generally hexagonal configuration, and a pair of spaced-apart axial projections 522' that project axially from the main body 512'. A threaded portion 518' is positioned axially between the nut portion 516' and the projections 522'. The axial projections include notches 524' for facilitating terminating wires. The central conductor 514' projects outward from the main body 512' at a location between the axial projections 522'.

Referring again to figure 19, the rear interface assembly 500 includes a dielectric support 506 having a front side 508 that faces the jack mount 22 and a back side 510 that faces away from the jack mount 22. A circuit board 507 is positioned between the support 506 and the jack mount 22. The coaxial connectors 502 project outward from the back side 510 to provide access for connections. As shown in figure 20, the nut portions 516 of the connectors 502 are mounted within hexagon-shaped recesses 509 defined by the support 506. The nut portions 516 seat upon shoulders (not shown) within the recesses 509.

The circuit board 507, the jack mount 22 and the dielectric support 506 define coaxially aligned openings sized to receive fasteners 569 (e.g., bolts or screws) for connecting the pieces together. The fasteners 569 are preferably press fit through captivation washers (not shown) that hold the pieces 22, 507 and 506 together after assembly. The fasteners 569 are also used to connect the pieces 22, 507 and 506 to the chassis 20 (shown in Figure 1).

A receptacle 513 for connection to one of the receptacles 54 of the power strip 52 also projects outward from the back side 510. The receptacle 513 is arranged to house a voltage lead 562, a return lead 561 and a sleeve ground lead 560. The leads 560-562 are electrically connected to the circuit board 507.

As shown in figure 19, the axial projections 522 and center conductors 514 extend through the dielectric support 506 and into chambers 546 formed in the front side 508 of the support 506. The front side 508 of the support 506 also defines a plurality of pockets 525 in which baluns 526 are retained or housed. One balun 526 corresponds to each connector 502. The front side 508 further includes a plurality of mounting bosses or pedestals 528 in which a plurality of connection pins 530 are press fit or staked. The pins 530 project outward from the front side 508 and are arranged in a predetermined array that corresponds to an array of contacts (e.g., plated through-holes) of the circuit board 507. To accommodate the arrangement of the pins 530, the circuit board 507 typically has a different contact and circuit pathway configuration than the circuit board 68 of the twisted pair rear interface assembly 64.

Referring now to figure 27, the dielectric support 506 includes a connector support piece 532 that is detachably connected to a balun housing piece 534. The balun housing piece 534 includes the generally rectangular pockets 525 for retaining the baluns 526, and the pedestals 528 for mounting the pins 530. The connectors 502 are secured to the connector support piece 532 by internally threaded lock rings 536 that are threaded on the first threaded portions 518 of the connectors 502. To support the connectors 502, the support piece 532 includes integrally formed cylindrical sleeves 538 defining through-holes 540 for receiving the

connectors 502. The cylindrical sleeves 538 also include rear seating surfaces 542 against which the lock rings 536 are tightened when the lock rings 536 are threaded on the first threaded portions 518 of the connectors. Interference between the lock rings 536 and the rear seating surfaces 542 prevent the connectors 502 from being  
5 pulled from the connector support piece 532. When the pieces 532 and 534 are connected, the rings 536 are concealed or housed within a chamber formed between the pieces 532 and 534.

The balun housing piece 534 defines the chambers 546 into which the extensions 522 and the central conductors 514 of the plugs 502 project when the  
10 assembly 500 is assembled. For example, at each chamber 546 the balun housing piece 534 defines two curved openings 550 (shown in figures 28–30) for receiving the extensions 522 of the connectors 502, and a circular opening 552 between the curved openings 550 for receiving the central conductors 514 of the plugs 502. The housing piece 534 also defines a plurality of covers 554 for covering one of each pair  
15 of extension members 522.

Referring still to figures 28–30, the conductive pins 530 are divided into eight pairs of tip and ring contacts with each pair of tip and ring contacts corresponding to one of the connectors 502. The pairs of pins 530 corresponding to the OUT connectors 502 have been labeled TO (tip out) and RO (ring out), while the  
20 pairs of pins 530 corresponding to the IN connectors 502 have been labeled TI (tip in) and RI (ring in). When a coaxial signal arrives through one of the OUT connectors 502, the balun 526 corresponding to the connector converts the unbalanced coaxial signals to balanced twisted pair signals (i.e., tip and ring signals). The tip signal is forwarded from the balun 526 to its corresponding TO pin and the  
25 ring signal is forwarded to its corresponding RO pin. From the RO and TO pins, the signals are directed to a corresponding jack mounted within the jack mount 22 via circuit pathways on the circuit board 507. The baluns 526 corresponding to the IN connectors 502 are adapted to convert balanced twisted pair signals into unbalanced coaxial signals. For example, when tip and ring signals from a cross-connected jack  
30 arrive at one of the baluns 526, the balun converts the tip and ring signals into a coaxial signal that is outputted through the balun's corresponding IN connector. It will be appreciated that the electrical pathways that connect the TO, RO, TI and RI pins to corresponding jacks mounted within the jack mount 22 can be schematically depicted in that same manner as the TO, RO, TI and RI contacts of figure 18. It will  
35 also be appreciated that the baluns 526 function to match the impedance between the unbalanced coaxial signals and the balanced twisted pair signals.

Still referring to figures 28–30, the baluns 526 preferably comprise torroid magnets each having two wound wires 570 and 572. The wires 570, 572

respectively terminate at ends 570a, 570b and 572a, 572b. To electrically connect one of the baluns 526, the ends 570a, 570b are respectively terminated at the central conductor 514 and one of the extensions 522 of the balun's corresponding connector 502, and the ends 572a, 572b are respectively terminated at the tip pin and the ring  
5 pin corresponding to the balun.

Having described preferred aspects and embodiments of the present invention, modifications and equivalents of the disclosed concepts may readily occur to one skilled in the art. However, it is intended that such modifications and equivalents be included within the scope of the claims which are appended hereto.

We claim:

1. A jack assembly comprising:

a jack mount having a front side and a rear side, the jack mount also including top and bottom supports defining a jack receiving region that opens

5 outward toward the front side of the jack mount;

a jack adapted to be slidably mounted in the jack receiving region defined between the top and bottom supports of the jack mount, the jack including a jack body formed of a dielectric material, the jack body defining a plurality of bores sized to receive plugs having tip and ring contacts;

10 the jack including a plurality of electrically conductive tip and ring springs, the tip springs being adapted to make electrical contact with the tip contacts of the plugs when the plugs are inserted within the bores, and the ring springs being adapted to make electrical contact with the ring contacts of the plugs when the plugs are inserted within the bores;

15 the jack including a plurality of normal contacts adapted to normally make electrical contact with the tip and ring springs;

a plurality of cross-connect contacts;

a rear interface assembly including a dielectric support having a first side that faces the jack mount and a second side that faces away from the jack mount, the rear interface assembly also including a plurality of rear connectors that project outward from the second side of the dielectric support;

20 the rear interface assembly further including a circuit board positioned between the jack mount and the dielectric support, the circuit board being configured to provide electrical connections between the rear connectors and the tip and ring springs, the circuit board also being configured to provide electrical connections between the cross-connect contacts and the normal contacts;

25 a resilient retaining member connected to one of the jack and the jack mount for securing the jack within the jack mount, the resilient retaining member being moveable between a first position in which the retaining member is adapted to retain the jack within the jack mount, and a second position in which the jack can be inserted into or removed from the jack mount; and

30 an electrical interface between the jack and the circuit board, the electrical interface being configured such that when the jack is removed from the jack mount, the jack is electrically disconnected from the circuit board.

35

2. The jack assembly of claim 1, wherein the rear connectors of the rear interface assembly comprise wire wrap members.



3. The jack assembly of claim 1, wherein the rear connectors of the rear interface assembly comprise coaxial connectors, and the rear interface assembly further includes baluns electrically connected to the coaxial connectors.
- 5 4. The jack assembly of claim 1, wherein the jack includes a first LED having first and second electrical leads, wherein the cross-connect contacts include a tracer lamp contact, and wherein the first lead is electrically connected to a power source and the second lead is electrically connected to the tracer lamp contact.
- 10 5. The jack assembly of claim 4, wherein one of the bores comprises a monitor bore and the jack further includes a return spring positioned between the monitor bore and the first LED, the return spring being positioned such that when a plug is inserted into the monitor bore, the return spring is pressed against the second lead of the first LED causing the first LED and a second LED of a second jack  
15 corresponding to the tracer lamp to be illuminated.
6. The jack assembly of claim 1, wherein the jack includes a front face positioned opposite from a rear face, the bores of the jack being defined by the front face, the jack including contact members that project outward from the rear face, the  
20 contact members being configured to form a portion of the electrical interface between the jack and the circuit board, and the contact members being electrically connected to the normal contacts, the tip springs and the ring springs.
7. The jack assembly of claim 6, wherein at least some of the contact members  
25 project outward a first distance from the rear face of the jack and others of the contact members project outward a second distance from the rear face of the jack, the first distance being greater than the second distance.
8. The jack assembly of claim 6, wherein the contact members are received  
30 within corresponding holes defined by the jack mount.
9. The jack assembly of claim 8, further comprising jack mount connectors mounted within the holes for providing electrical connections between the contact members and the circuit board.
- 35 10. The jack assembly of claim 9, wherein each jack mount connector includes opposing first and second portions between which a corresponding one of the contact members is received.

11. The jack assembly of claim 10, wherein the jack mount connectors are press-fit within the holes of the jack mount and include pins for providing the electrical connections with the circuit board.
- 5 12. The jack assembly of claim 3, wherein the baluns of the rear interface assembly are mounted on the dielectric support and are electrically connected to rear interface contact members that project outward from the first side of the support, the rear interface contact members being adapted to provide electrical connections between the baluns and the circuit board.
- 10 13. The jack assembly of claim 12, wherein the baluns are mounted within pockets defined by the dielectric support.
14. The jack assembly of claim 12, wherein the rear interface contact members  
15 comprise pins press fit within holes defined by bosses of the dielectric support.
15. The jack assembly of claim 12, wherein the dielectric support includes a first piece removeably connected to a second piece, the baluns being mounted on the first piece and the coaxial connectors being connected to the second piece.
- 20 16. The jack assembly of claim 15, wherein the coaxial connectors have threaded inner ends that extend through the second piece of the dielectric support, and the coaxial connectors are fastened to the second piece of the support by internally threaded members threaded on the threaded inner ends and positioned between the  
25 first and second pieces of the dielectric support.
17. The jack assembly of claim 15, wherein each coaxial connector includes a central pin and at least one ground extension that project through openings defined by the first piece of the support.
- 30 18. The jack assembly of claim 17, wherein each coaxial connector includes two ground extensions positioned on opposite sides of the central pin.
19. The jack assembly of claim 12, wherein the coaxial connectors have threaded  
35 inner ends that extend through the dielectric support, and the coaxial connectors are fastened to the dielectric support by internally threaded members threaded on the threaded inner ends.

20. The jack assembly of claim 1, wherein the cross-connect contacts are formed by wire wrap pins.
21. The jack assembly of claim 1, wherein the jack mount includes a first portion  
5 for mounting the jack, and a second portion for mounting the cross-connect contacts, the first and second portions being connected at a mechanical interface arranged and configured for allowing the second portion to be disconnected from the first portion.
22. The jack assembly of claim 21, wherein the mechanical interface includes a  
10 tongue and groove configuration.
23. The jack assembly of claim 1, further comprising a chassis in which the jack mount is mounted, the chassis including a top wall positioned opposite from a bottom wall, the top wall including a removable front portion for providing access to  
15 the jack mount.
24. The jack assembly of claim 1, wherein the jack is one of a plurality of jacks mountable within the jack mount, each of the jacks including a separate resilient retaining member for individually retaining each jack within the jack mount.  
20
25. The jack assembly of claim 24, wherein the plurality of jacks includes odd jack and even jacks having different configurations, and the jack mount defines first mounting locations configured to exclusively receive the odd jacks and second mounting locations configured to exclusively receive the even jacks.  
25
26. The jack assembly of claim 25, wherein the first mounting locations of the jack mount include top and bottom channels configured to receive and complement top and bottom portions of the odd jacks, and the second mounting locations define top and bottom channels configured to receive and complement top and bottom  
30 portions of the even jacks.
27. A jack assembly comprising:  
a jack mount having a front side and a rear side;  
a jack positioned at the front side of the jack mount, the jack  
35 including a jack body formed of a dielectric material, the jack body defining a plurality of bores each sized to receive a plug having a tip contact and a ring contact;  
the jack including a plurality of electrically conductive tip and ring springs, the tip springs being adapted to make electrical contact with the tip contacts

of the plugs when the plugs are inserted within the bores, and the ring springs being adapted to make electrical contact with the ring contacts of the plugs when the plugs are inserted within the bores;

5           the jack including a plurality of normal contacts adapted to normally  
make electrical contact with the tip and ring springs;  
          a plurality of cross-connect contacts; and  
          a rear interface assembly positioned at the rear side of the jack mount,  
the rear interface assembly including a dielectric support having a first side that  
faces the jack mount and a second side that faces away from the jack mount, the rear  
10 interface assembly also including a plurality of baluns supported by the dielectric  
support, the rear interface assembly further including a plurality of coaxial  
connectors that project outward from the second side of the support and are  
electrically connected to the baluns, the rear interface assembly further including  
contact members that project outward from the first side of the support and are  
15 electrically connected to the baluns, and a circuit board in electrical contact with the  
contact members of the rear interface assembly, the circuit board providing electrical  
connections between the contact members and the tip and ring springs, the circuit  
board also providing electrical connections between the cross-connect contacts and  
the normal contacts.

20

28.    The jack assembly of claim 27, wherein the baluns are mounted within  
pockets defined by the dielectric support.

25 29.    The jack assembly of claim 27, wherein the contact members comprise pins  
press fit within holes defined by the dielectric support.

30.    The jack assembly of claim 27, wherein the dielectric support includes a first  
piece removeably connected to a second piece, the baluns being mounted on the first  
piece and the coaxial connectors being connected to the second piece.

30

31.    The jack assembly of claim 30, wherein the coaxial connectors have threaded  
inner ends that extend through the second piece of the dielectric support, and the  
coaxial connectors are fastened to the second piece of the support by internally  
threaded members threaded on the threaded inner ends and positioned between the  
35 first and second pieces of the dielectric support.

32. The jack assembly of claim 30, wherein each coaxial connector includes a central pin and at least one ground extension that project through openings defined by the first piece of the dielectric support.
- 5 33. The jack assembly of claim 32, wherein each coaxial connector includes two ground extensions positioned on opposite sides of the central pin.
34. The jack assembly of claim 27, wherein the coaxial connectors have threaded inner ends that extend through the dielectric support, and the coaxial connectors are  
10 fastened to the dielectric support by internally threaded members threaded on the threaded inner ends.
35. A jack assembly comprising:
- 15 a jack mount having a front side and a rear side;  
a jack positioned at the front side of the jack mount, the jack including a jack body formed of a dielectric material, the jack body defining a plurality of bores each sized to receive a plug having a tip contact and a ring contact;  
the jack including a plurality of electrically conductive tip and ring springs, the tip springs being adapted to make electrical contact with the tip contacts  
20 of the plugs when the plugs are inserted within the bores, and the ring springs being adapted to make electrical contact with the ring contacts of the plugs when the plugs are inserted within the bores;  
the jack including a plurality of normal contacts adapted to normally make electrical contact with the tip and ring springs;  
25 a plurality of cross-connect contacts electrically connected to the normal contacts;  
first and second rear interface assemblies that can be selectively secured to the rear side of the jack mount;  
the first rear interface assembly including a plurality of wire  
30 termination members, the wire termination members being electrically connected to the tip and ring springs when the first rear interface assembly is secured to the jack mount; and  
the second rear interface assembly including a plurality of coaxial connectors, each coaxial connector being electrically connected to a balun, and the  
35 baluns being electrically connected to the tip and ring springs when the second rear interface assembly is secured to the jack mount.

36. The jack assembly of claim 35, wherein the first rear interface assembly includes a circuit board including circuitry for electrically connecting the cross-connect contacts with the normal contacts, and for electrically connecting the wire termination members with the tip and ring springs.

5

37. The jack assembly of claim 35, wherein the second rear interface assembly includes a circuit board including circuitry for electrically connecting the cross-connect contacts with the normal contacts, and for electrically connecting the baluns with the tip and ring springs.

10

38. The jack assembly of claim 35, wherein the first rear interface assembly includes a first circuit board and the second rear interface assembly includes a second circuit board that is different from the first circuit board.

15 39. A jack comprising:

a jack body formed of a dielectric material, the jack body defining a plurality of bores sized to receive plugs having tip and ring contacts;

a plurality of electrically conductive tip and ring springs mounted at the jack body, the tip springs being adapted to make electrical contact with the tip contacts of the plugs when the plugs are inserted within the bores, and the ring springs being adapted to make electrical contact with the ring contacts of the plugs when the plugs are inserted within the bores;

a plurality of normal contacts adapted to normally make electrical contact with the tip and ring springs;

25 the jack body including a front face positioned opposite from a rear face, the bores of the jack being defined by the front face;

a plurality of contact members that project outward from the rear face, the contact members being electrically connected to the normal contacts, the tip springs and the ring springs; and

30 at least some of the contact members projecting outward a first distance from the rear face of the jack and others of the contact members projecting outward a second distance from the rear face of the jack, the first distance being greater than the second distance.

35 40. A jack mount comprising:

a jack mount body having a front side and a rear side, the jack mount body defining a jack receiving region that opens outward toward the front side of the jack mount body;

the jack mount body including a rear wall positioned at the rear side of the jack mount body, the rear wall defining a plurality of through-holes; and  
a plurality of electrical connectors mounted within the through-holes, each electrical connector including opposing first and second cantilever members  
5 that are press-fit within a corresponding one of the through-holes and a connector pin connected to the cantilever members, the connector pins being sized to project outward from the rear side of the jack mount body.

41. A method for mounting electrical connectors in a jack mount, the method  
10 comprising:

providing a plurality of the electrical connectors arranged in a row and connected to an insertion tool;  
using the insertion tool to concurrently insert the row of electrical  
connectors into a row of through-holes defined by the jack mount; and  
15 disconnecting the electrical connectors from the insertion tool.

42. The method of claim 41, wherein the electrical connectors are press-fit within the through-holes.

20 43. A jack mount comprising:

a jack mount body having a front side and a rear side, the jack mount body including a jack receiving portion that opens outward toward the front side of the jack mount body; and  
a cross-connector mounting body at which there are mounted a  
25 plurality of cross-connect contacts, the cross-connector mounting body and the jack mount body being connected at a mechanical interface arranged and configured for allowing the cross-connector mounting body to be disconnected from the jack mount body.

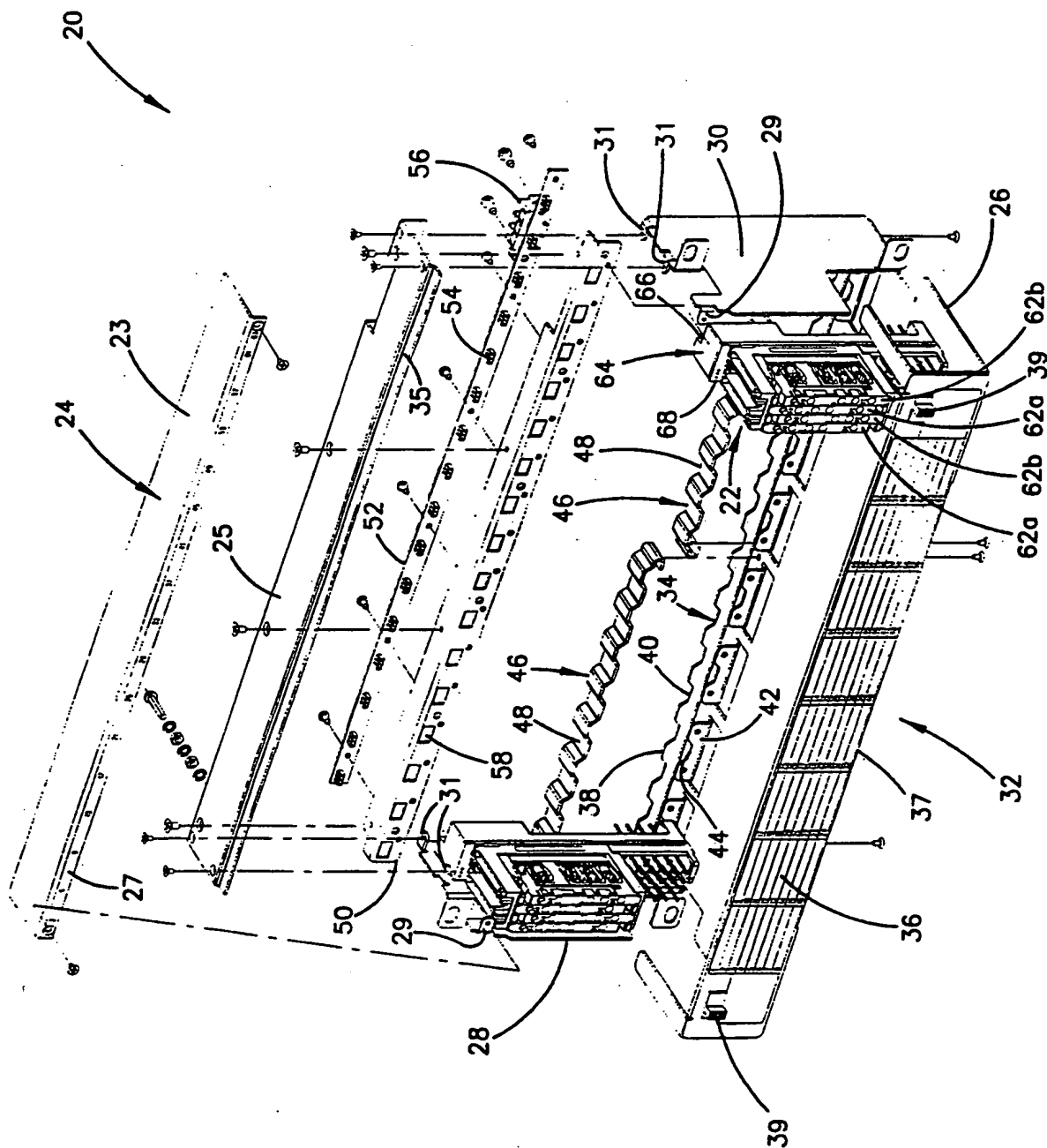
30 44. The jack assembly of claim 43, wherein the mechanical interface includes a tongue and groove configuration.

45. A jack mount assembly comprising:  
a jack mount having a front side and a rear side; and  
35 a rear interface assembly positioned at the rear side of the jack mount, the rear interface assembly including a dielectric support having a first side that faces the jack mount and a second side that faces away from the jack mount, the rear interface assembly also including a plurality of baluns supported by the dielectric

- support, the rear interface assembly further including a plurality of coaxial connectors that project outward from the second side of the support and are electrically connected to the baluns, the rear interface assembly further including contact members that project outward from the first side of the support and are
- 5 electrically connected to the baluns, and a circuit board in electrical contact with the contact members of the rear interface assembly, the circuit board providing electrical connections between the contact members and electrical contact members mounted at the jack mount.



FIG. 1



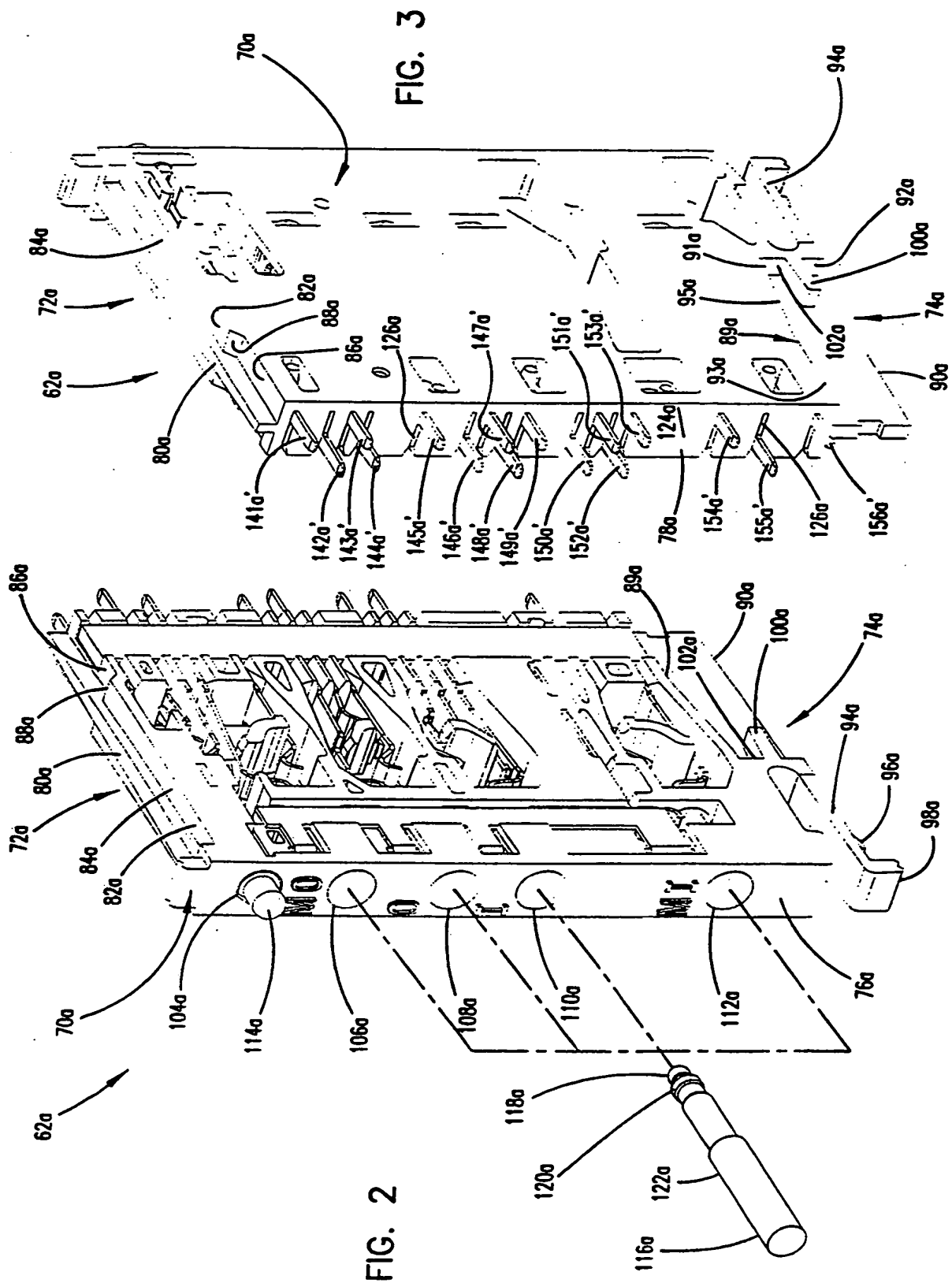
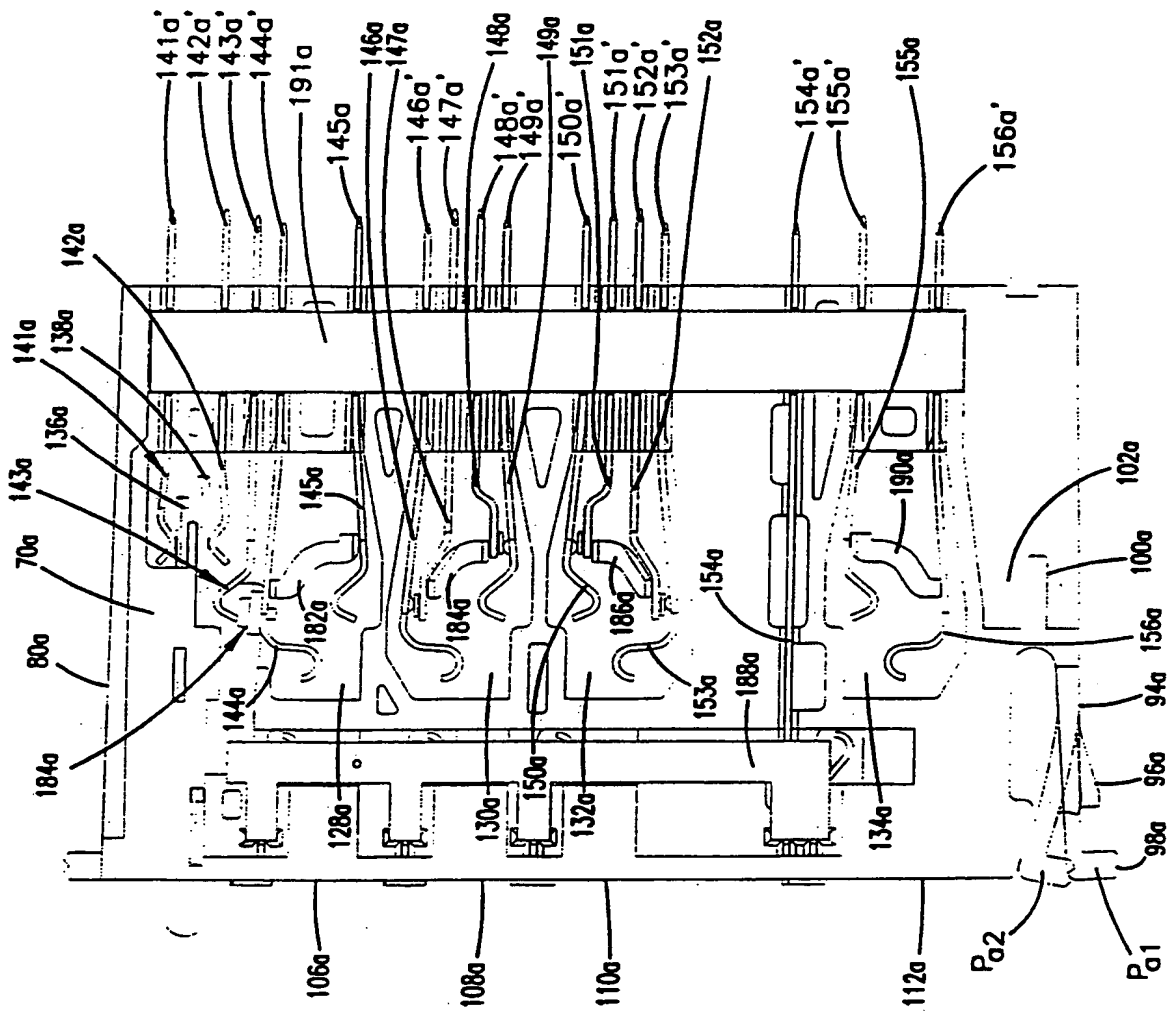
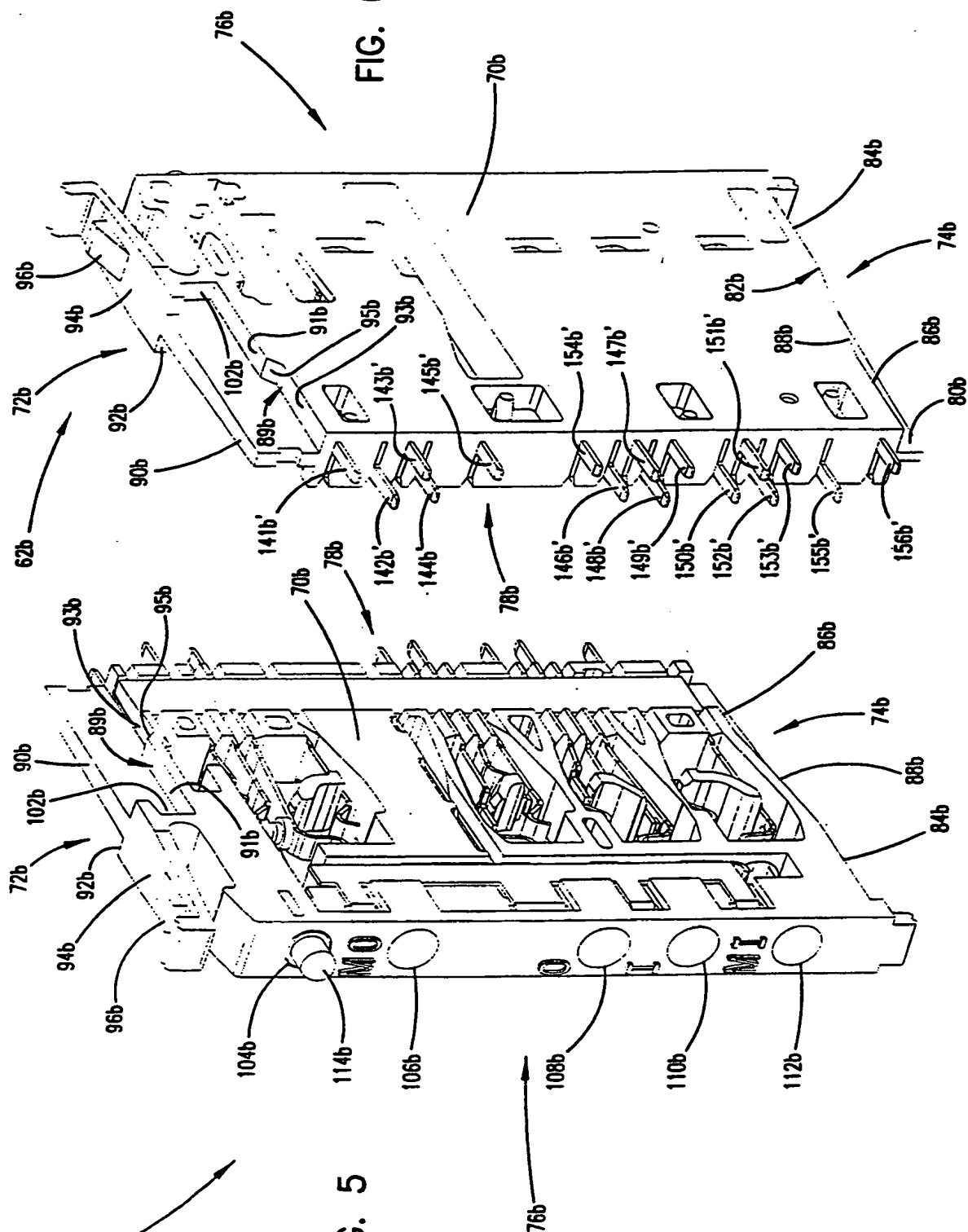


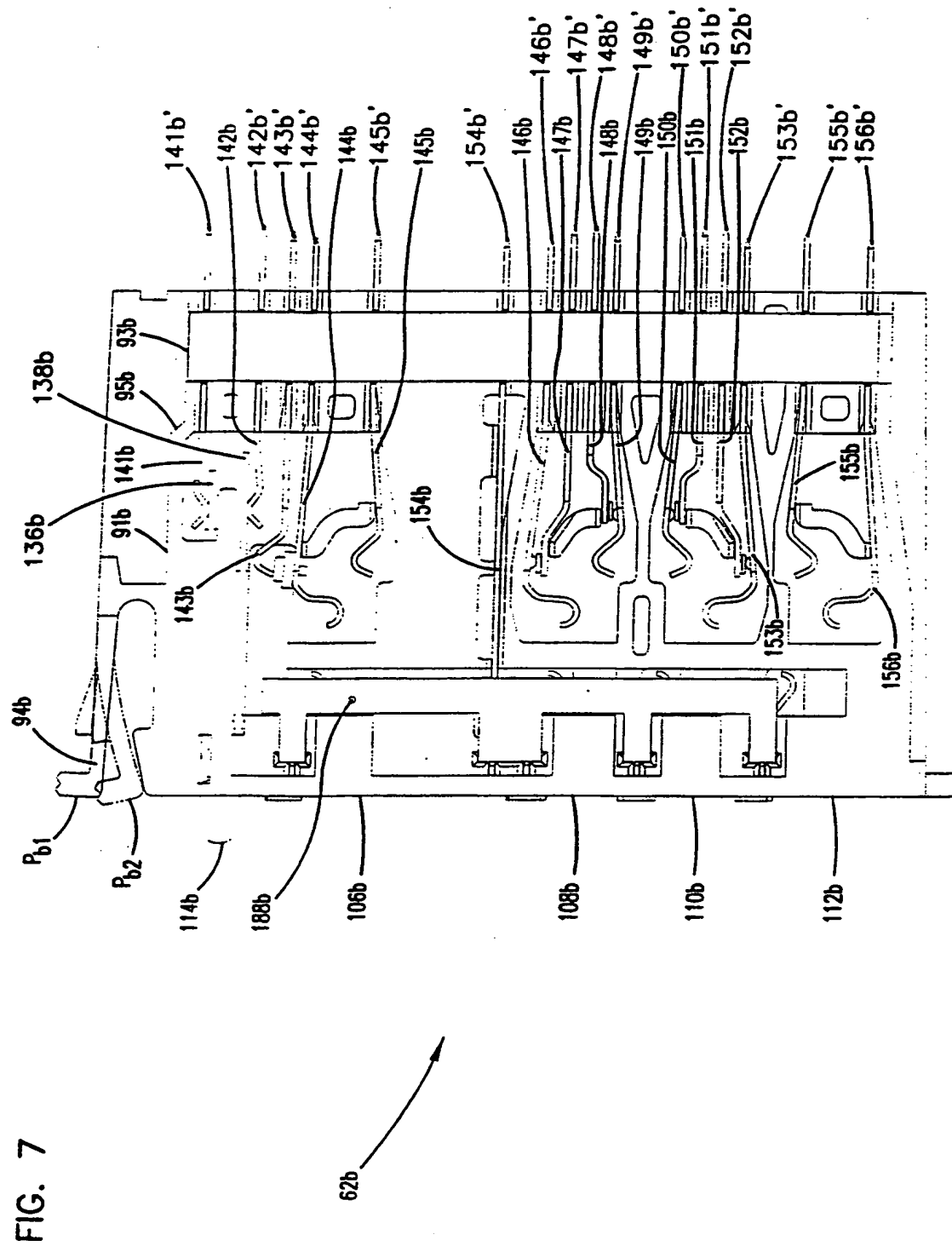
FIG. 4

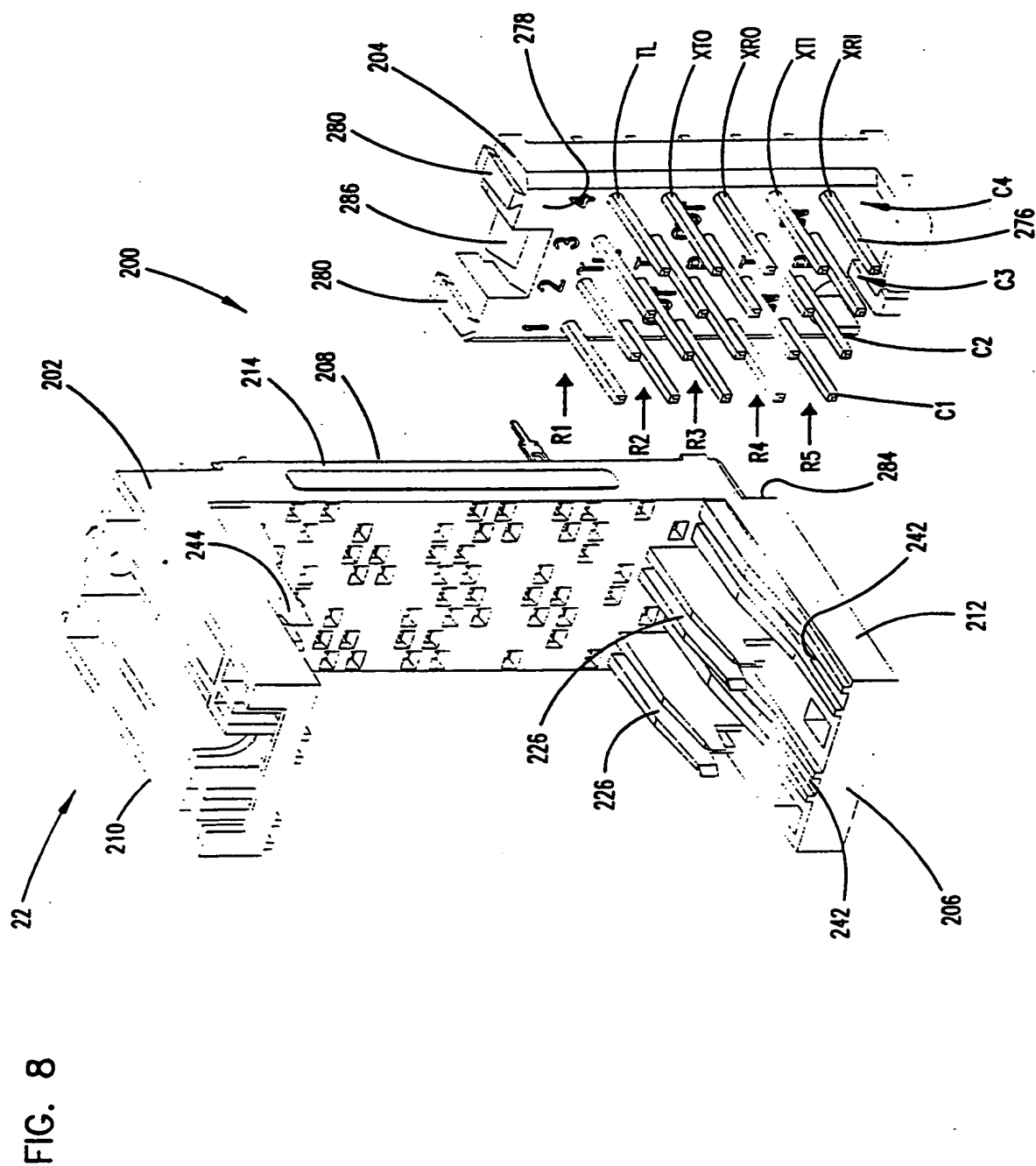


**FIG. 6**



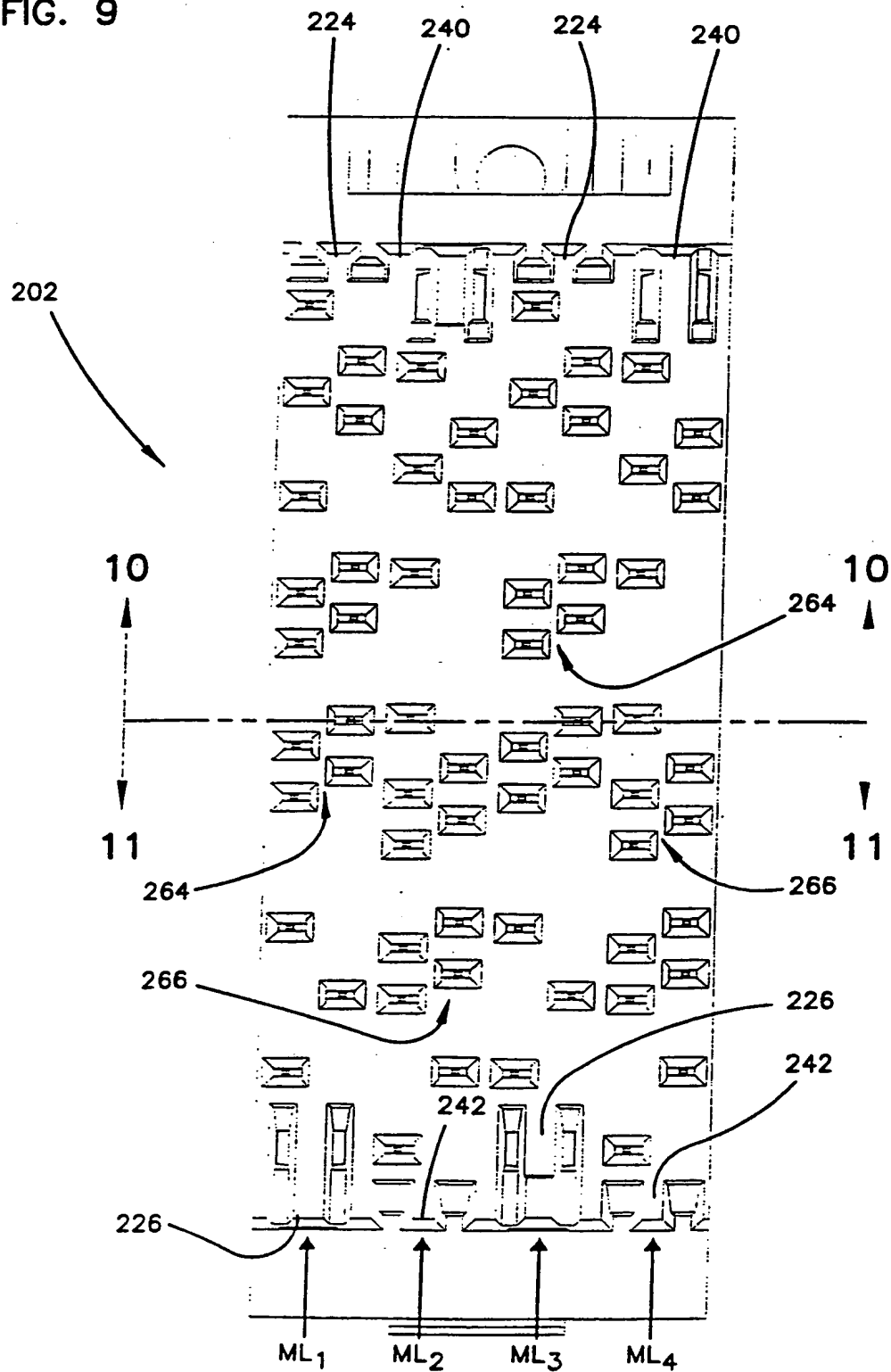
**FIG. 5**

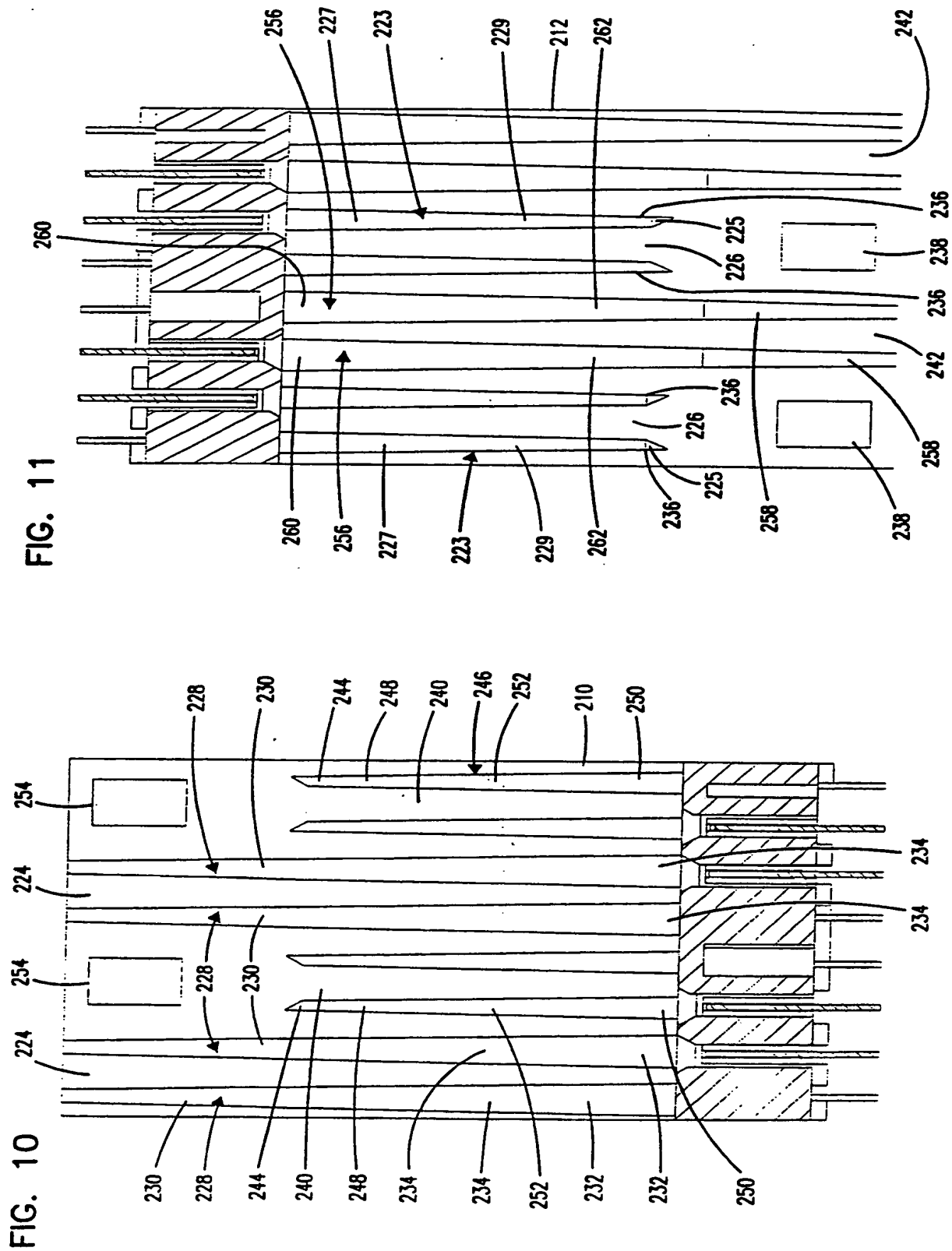




7/20

FIG. 9







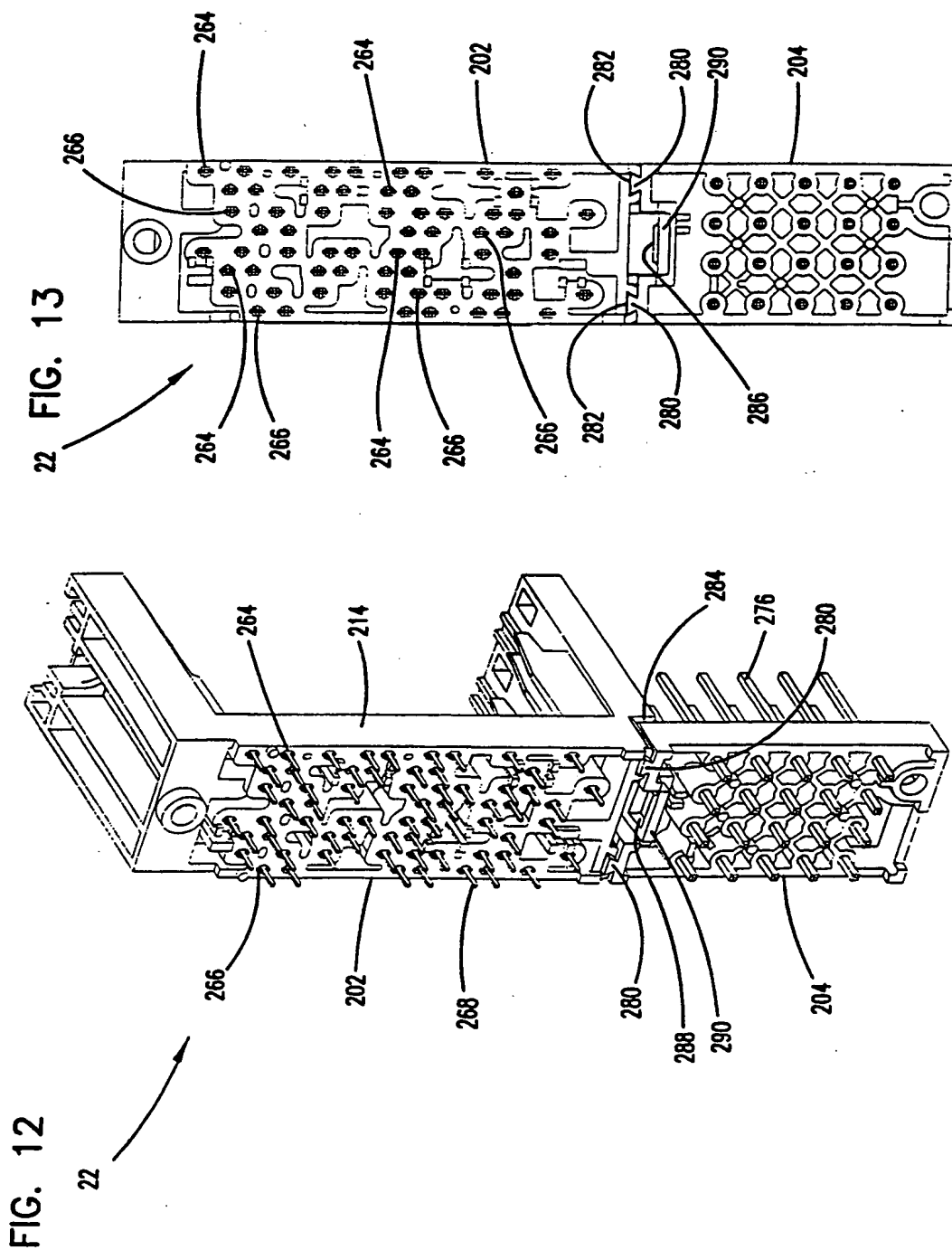
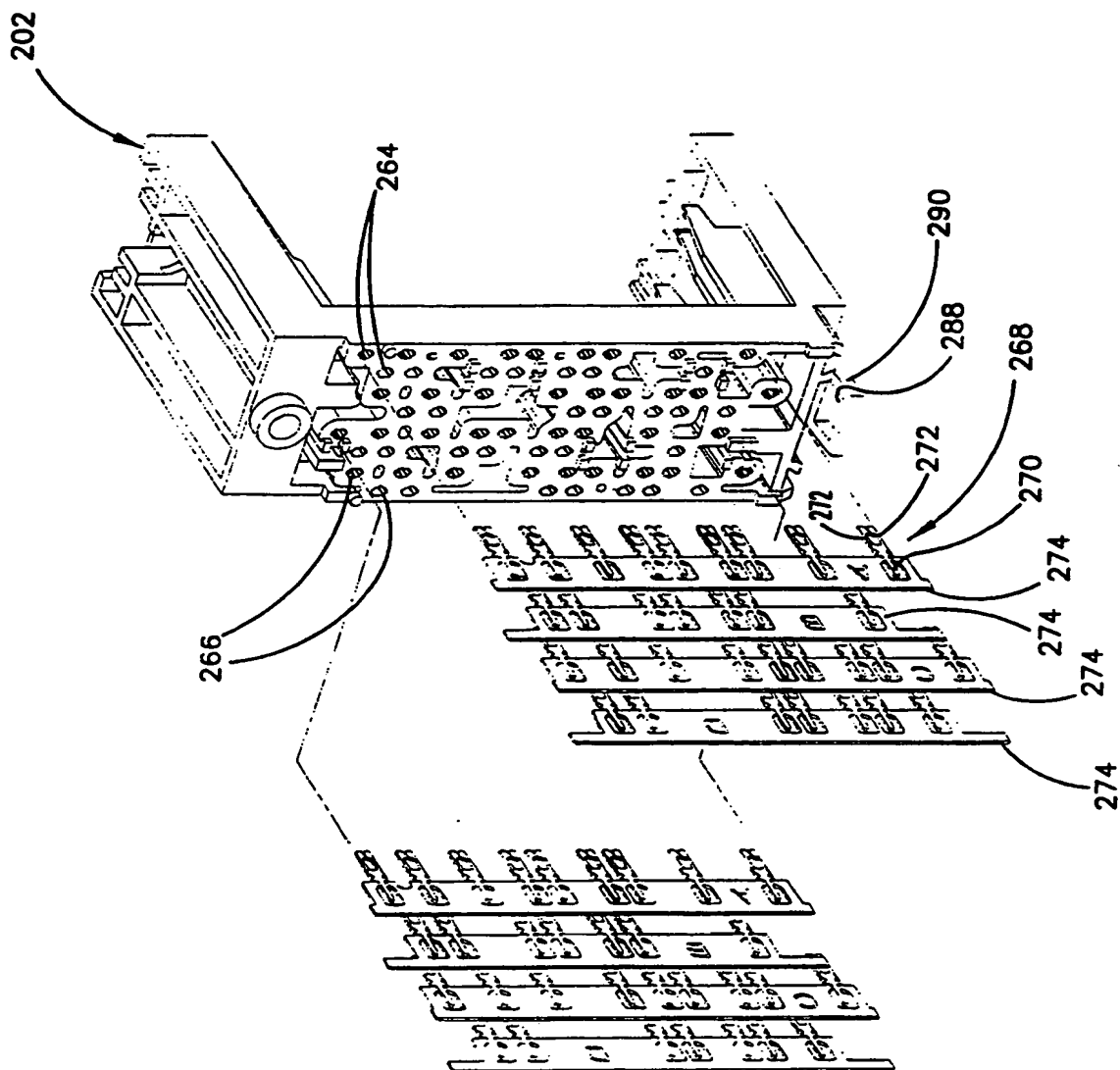


FIG. 14



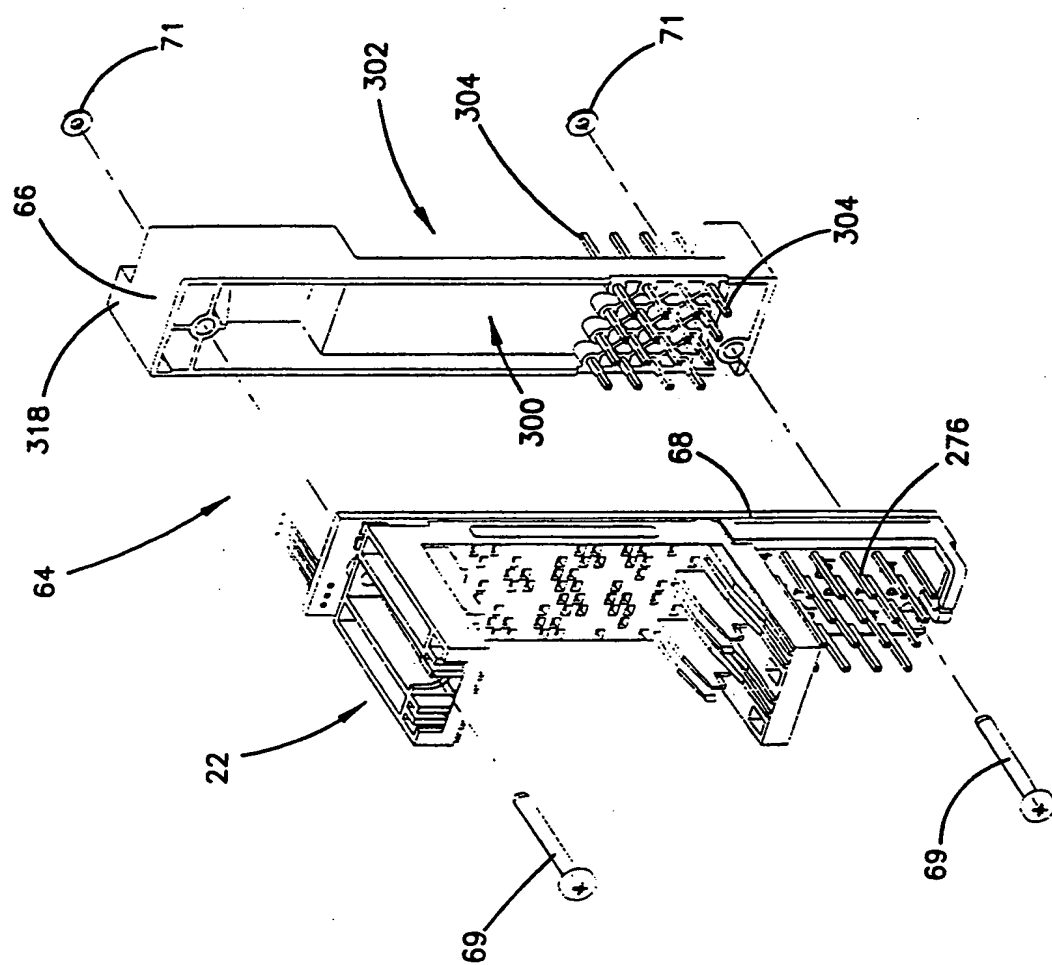


FIG. 15

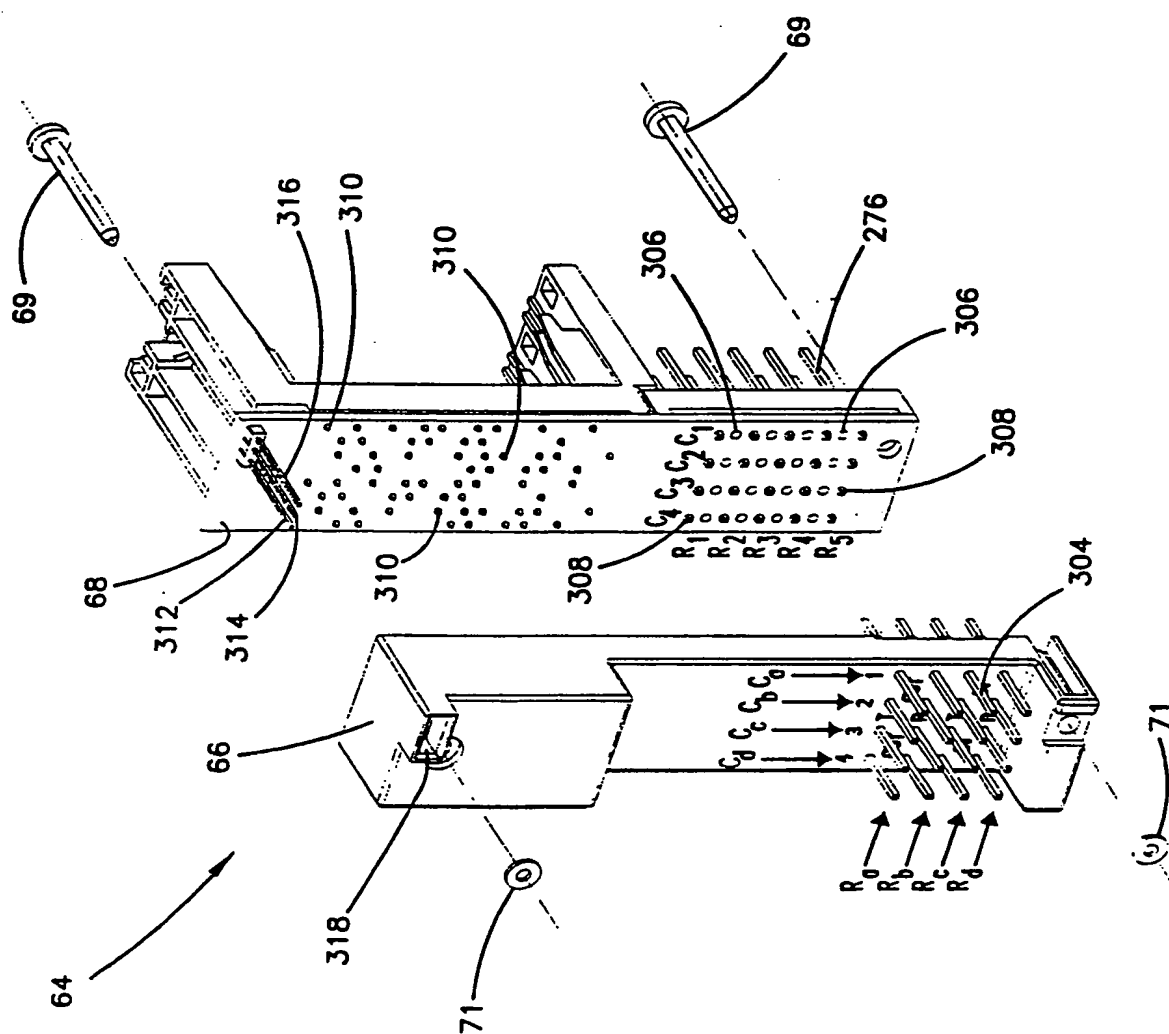


FIG. 16

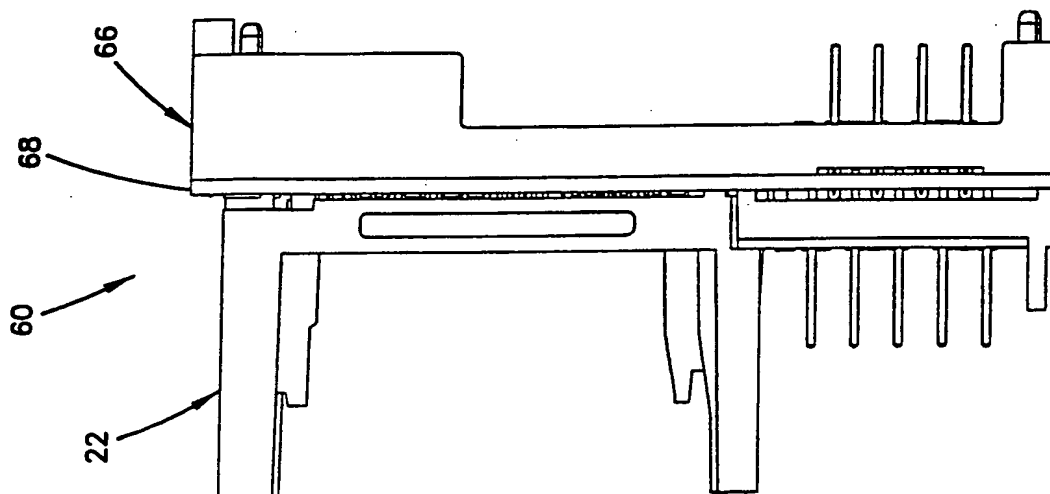


FIG. 17



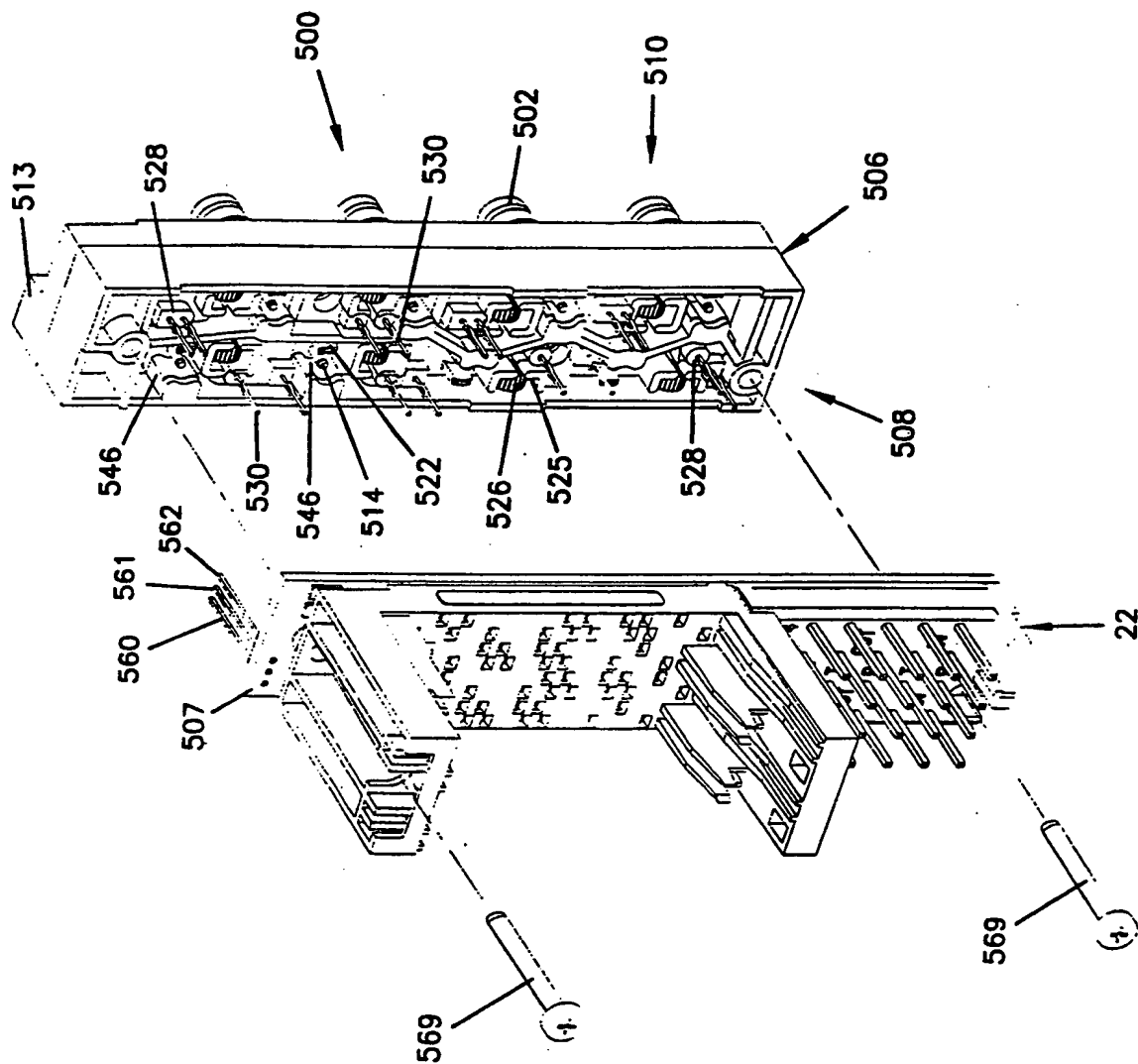


FIG. 19

FIG. 20

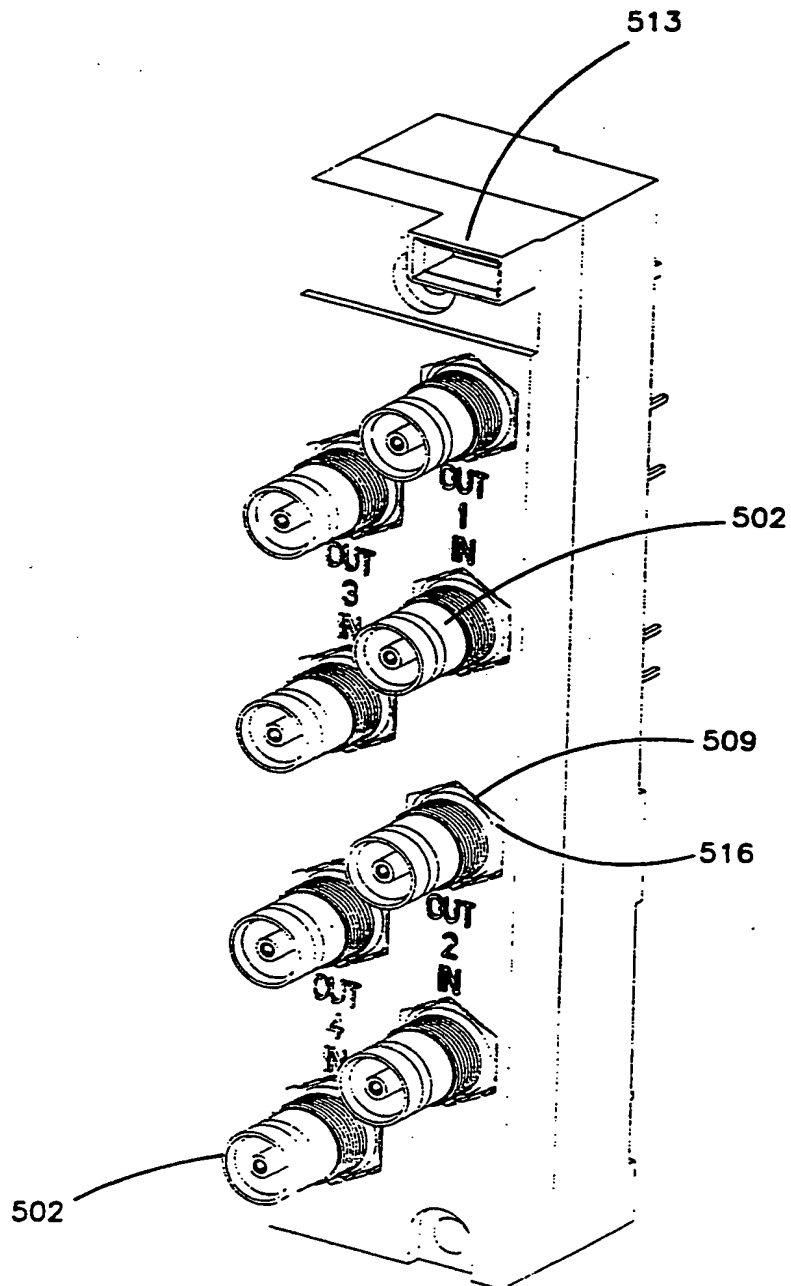




FIG. 21

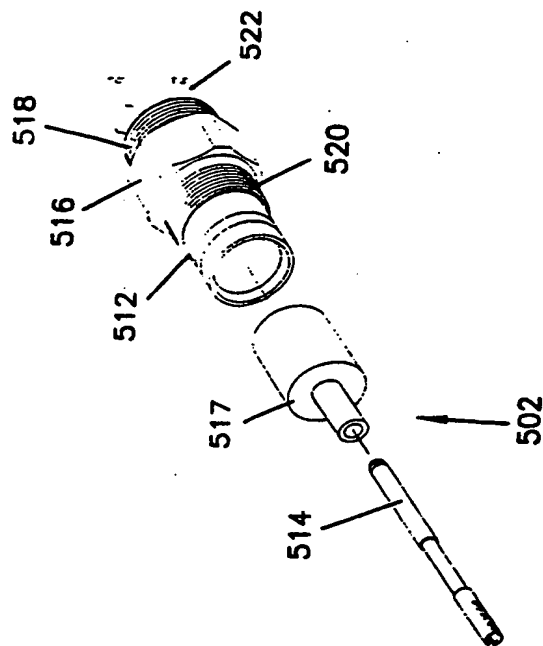


FIG. 22

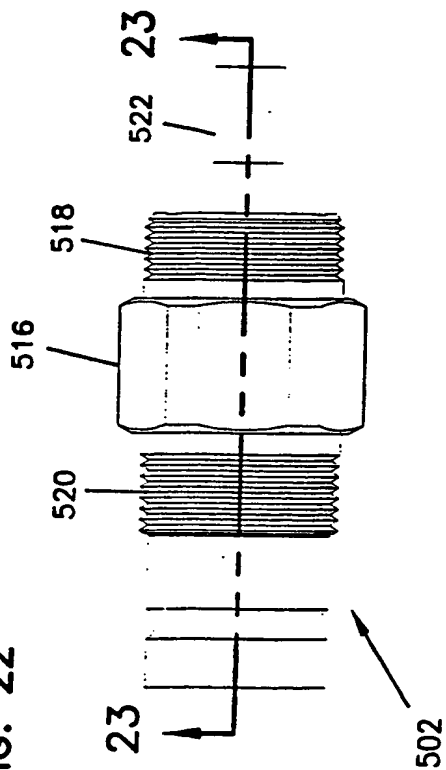


FIG. 23

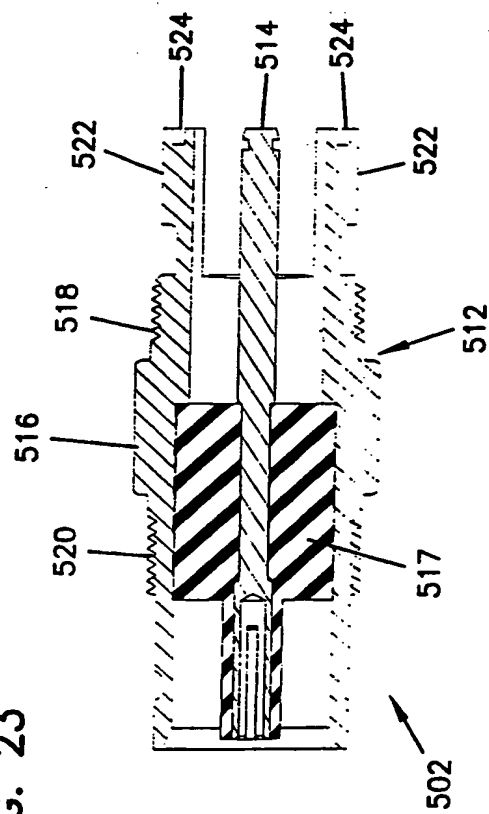


FIG. 25

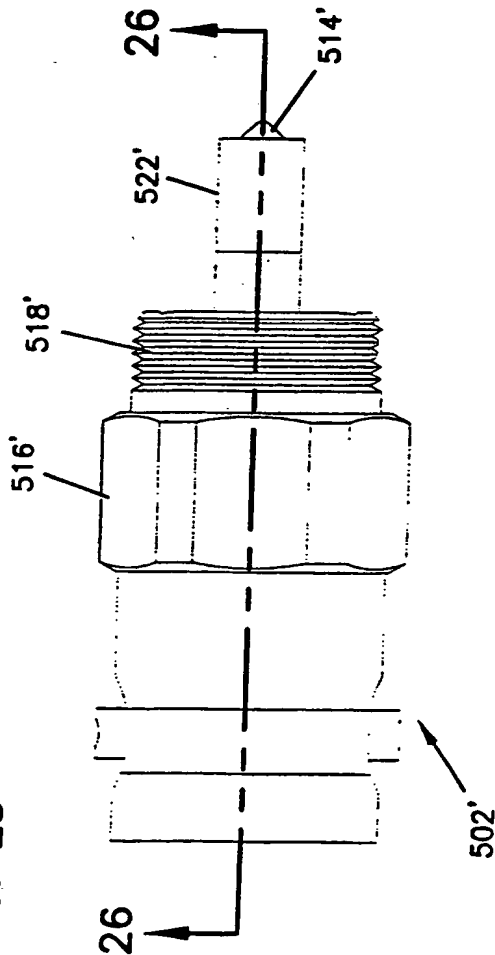


FIG. 24

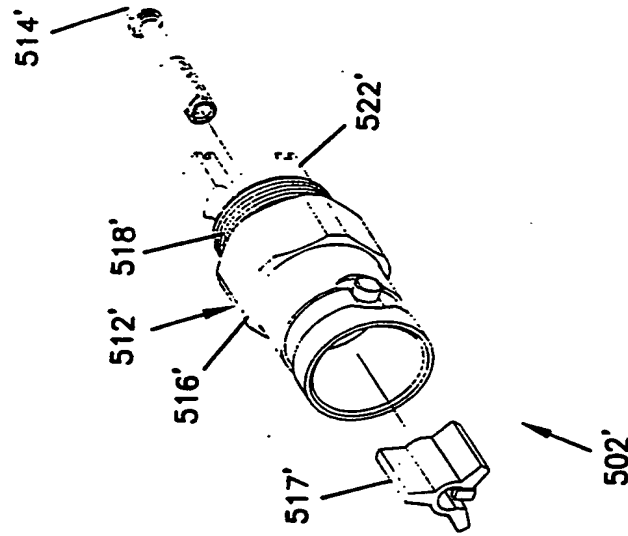


FIG. 26

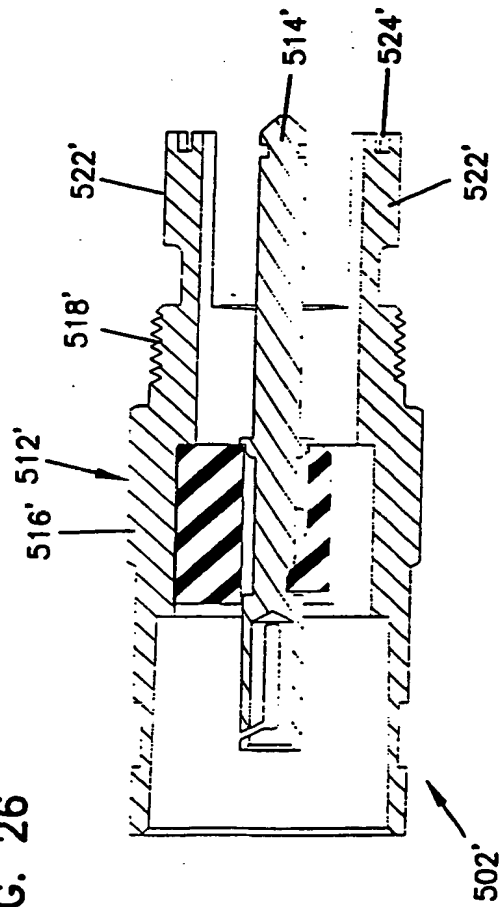


FIG. 27

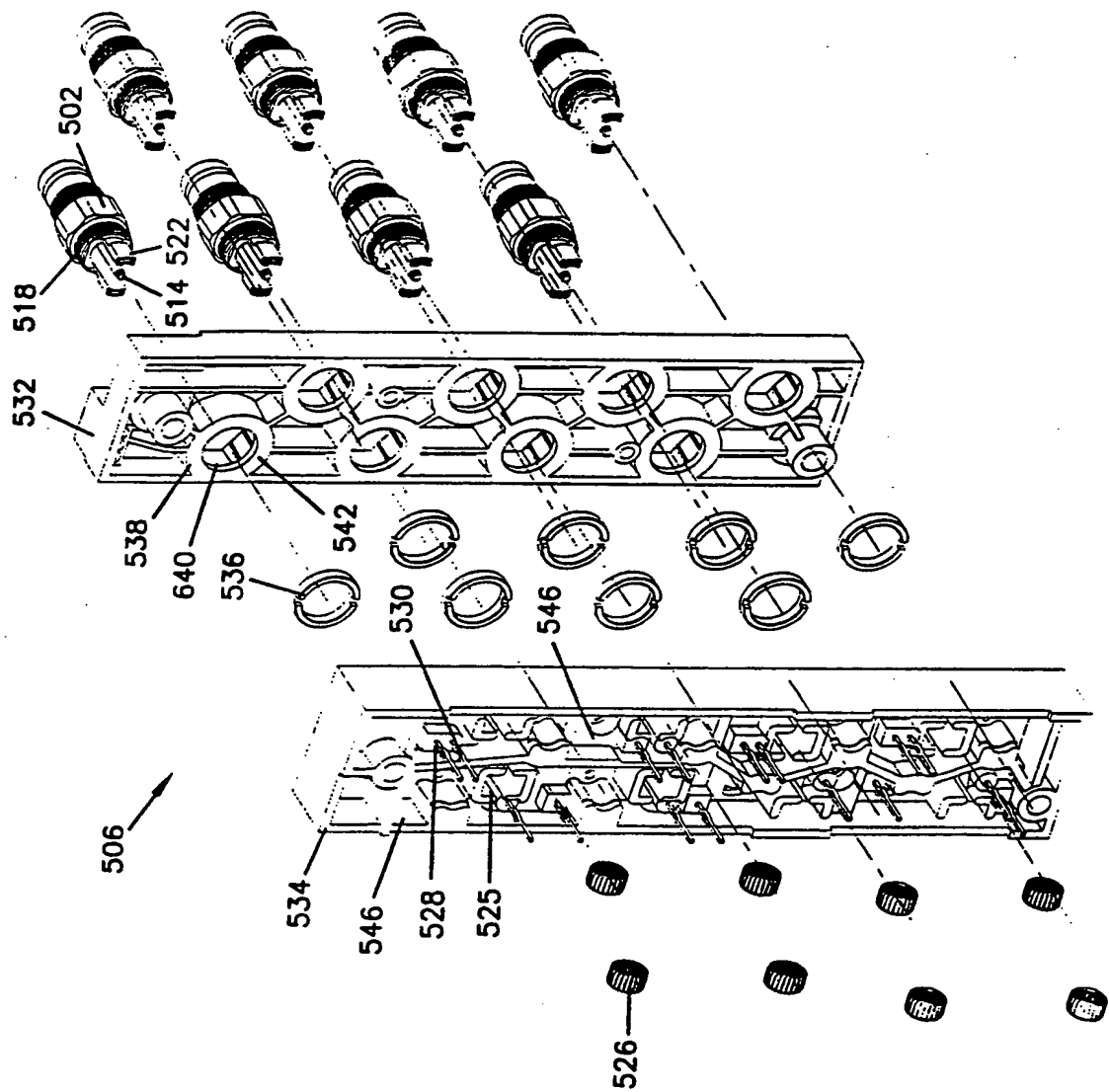
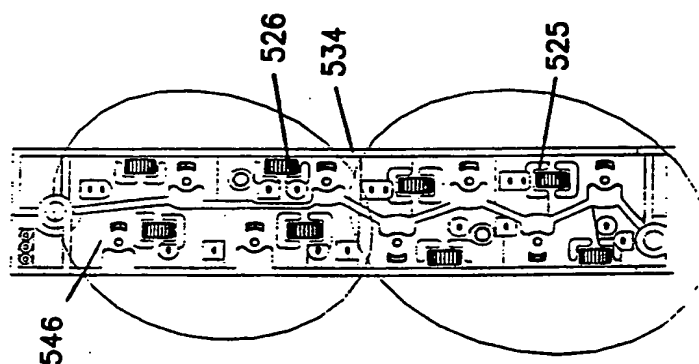


FIG. 28



**FIG. 29**

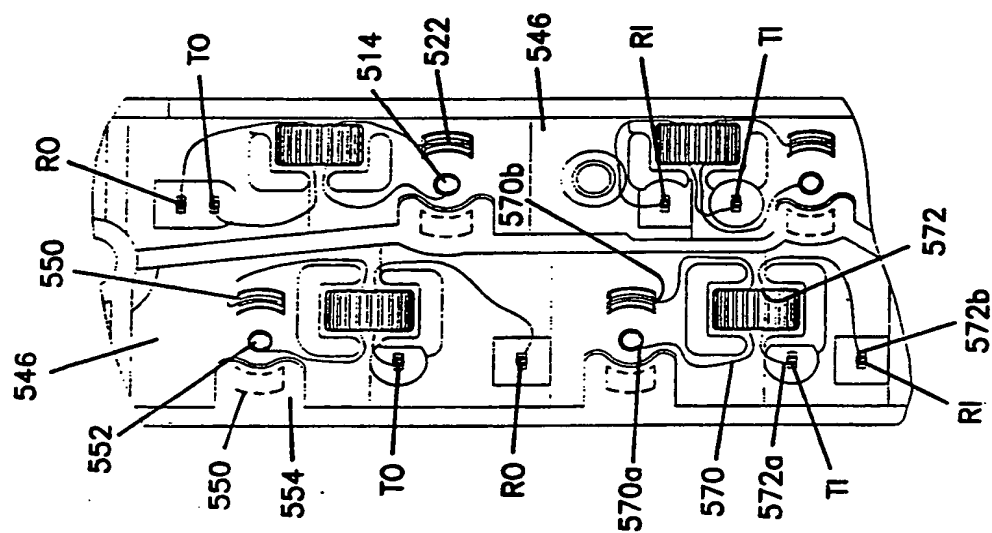
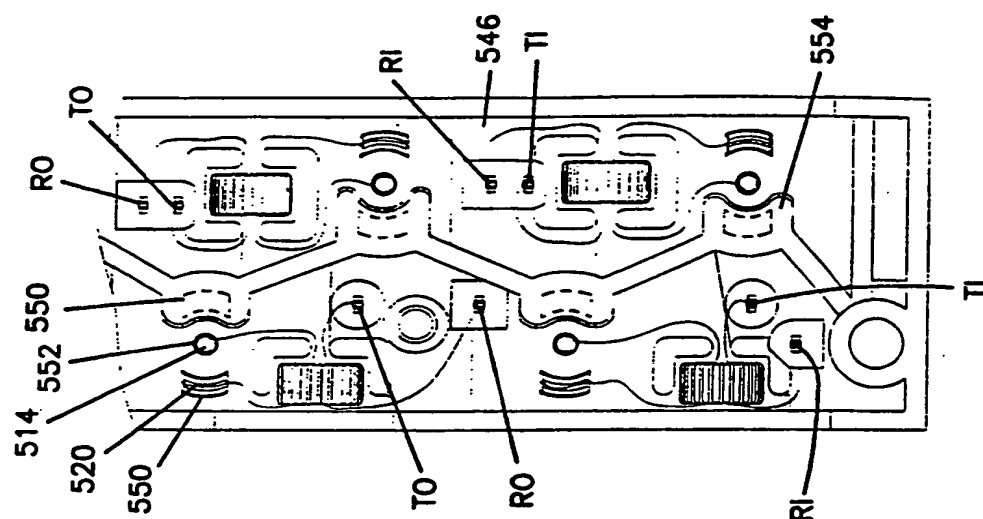


FIG. 30



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International Bureau



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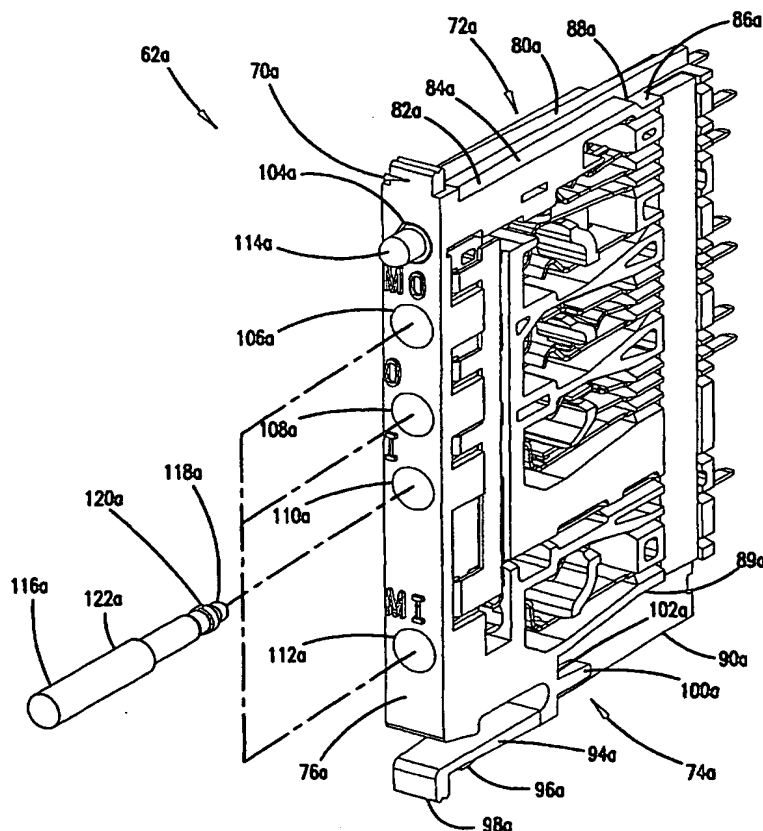
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(10) International Publication Number  
WO 00/30219 A3

- (51) International Patent Classification<sup>7</sup>: H04Q 1/14, (72) Inventors: HENNEBERGER, Roy, Lee; 12080 Gantry Lane, Apple Valley, MN 55124 (US). DEWEY, James, D.; 5025 Norwood Lane, Plymouth, MN 55442 (US). SA-JADI, Ahmad; 4368 Garden Terrace, Eagan, MN 55123 (US).
- (21) International Application Number: PCT/US99/26271
- (22) International Filing Date: 5 November 1999 (05.11.1999) (74) Agent: BRUESS, Steven, C.; Merchant & Gould P.C., 3100 Norwest Center, 90 South Seventh Street, Minneapolis, MN 55402-4131 (US).
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data: 09/191,213 12 November 1998 (12.11.1998) US
- (71) Applicant: ADC TELECOMMUNICATIONS, INC. [US/US]; 12501 Whitewater Drive, Minnetonka, MN 55343 (US).
- (81) Designated States (*national*): AE, AL, AM, AT, AT (utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, CZ (utility model), DE, DE (utility model), DK, DK (utility model), DM, EE, EE (utility model), ES, FI, FI (utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (utility model), SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

[Continued on next page]

(54) Title: JACK ASSEMBLY



(57) Abstract: The invention relates to a jack assembly including a jack mount with a jack receiving region. A jack is adapted to be slidably mounted in the jack receiving region. The jack includes a jack body formed of a dielectric material and a plurality of electrically conductive tip and ring springs. The jack body defines a plurality of bores sized to receive plugs having tip and ring contacts. The jack assembly further includes a plurality of cross-connect contacts and a rear interface assembly including a dielectric support. A plurality of rear connectors project outward from the dielectric support, and a circuit board is positioned between the jack mount and the dielectric support. The circuit board provides connections between the cross-connect contacts and the normal contacts. An electrical interface between the jack and the circuit board is configured such that when the jack is removed from the jack mount, the jack is automatically disconnected from the circuit board.

WO 00/30219 A3



(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

(88) Date of publication of the international search report:  
27 September 2001

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

**Published:**

— with international search report

# INTERNATIONAL SEARCH REPORT

International Application No

PC, US 99/26271

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H04Q1/14 H01R12/14 H01R13/00 H01R24/04

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H01R H04Q H05K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 96 38884 A (TELECT INC) 5 December 1996 (1996-12-05) the whole document	1-40, 43-45
X	US 4 969 258 A (FISHER JAMES ET AL) 13 November 1990 (1990-11-13) column 1, line 38 -column 2, line 10 column 3, line 53 -column 4, line 2; figures abstract	41,42
X	US 5 092 029 A (FISHER JAMES ET AL) 3 March 1992 (1992-03-03) column 5, line 20 -column 6, line 2; figures abstract	41,42

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

### \* Special categories of cited documents :

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

\*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

\*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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\*G\* document member of the same patent family

Date of the actual completion of the international search

10 April 2001

Date of mailing of the international search report

04.05.01

Name and mailing address of the ISA

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Fax: (+31-70) 340-3016

Authorized officer

Kerstin Waczinska

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US99/26271

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: 1-40, 43-45 (all in part)  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:  
  
see extra sheet
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see extra sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

### Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.  
☒ No protest accompanied the payment of additional search fees.

Form PCT-IS/A/210 (continuation of first sheet (1)) (July 1998)



# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US99/26271

## Continuation of Box I

The present application fails to comply with the clarity and conciseness requirements of Article 6 PCT to such an extent that a meaningful search on basis of the claims 1-40, 43-45 is impossible for the following reasons.

The description does not reveal which problem the invention relating to a jack assembly is intended to solve and consequently, there is no solution indicated. Claim 1 only contains an enumeration of a number of features relating to a jack assembly and to some extent the design of the features. Since it is difficult to determine the matter for which protection is sought, the search has been carried out for a jack assembly comprising the features mentioned in claim 1.

The novelty search done has revealed WO96/38884 A1 as representing particular relevant prior art useful for the understanding, searching and examination of the application. The document discloses the technical features stated in claim 1.

In view of this document the jack assembly mentioned in claim 1 lacks novelty. The independent claims 27, 35, 39, 40, 43 and 45 do not shear in common any special technical feature within the meaning of PCT Rule 13.2. Therefore, the requirement of unity of invention is not fulfilled considering claims 27, 35, 39, 40, 43 and 45. Furthermore, as far as the scope of the claims has been understood, at least what is claimed in claims 2, 3, 4, 6, 8, 9, 12, 20, 23, 24, 27, 35, 36, 37, 38, 45 does not comprise any technical features that defines a contribution over the prior art, i.e. is not new or inventive.

Therefore, claims 5, 7, 10, 13, 14, 15, 19, 21, 25, 28, 29, 30, 34 referring to claims 2, 3, 4, 6, 8, 9, 12, 20, 23, 24, 27, 35, 36, 37, 38, 45 will define a large number of inventions where non-unity *a posteriori* arises. If the requirement of unity of invention is fulfilled or not for each of these claims, cannot be determined with a reasonable effort due to the number of inventions. Neither would it be meaningful to require a large number of additional search fees.

Consequently, it is unduly burdensome to determine the matter for which protection is sought. The novelty search done is only considered to cover the features mentioned in claim 1.

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US99/26271

## Continuation of Box II

The International Searching Authority found multiple (groups of) inventions in this international application, as follows:

- I. Claims 1-40, 43-45 relate to a jack assembly, a jack, a jack mount or a jack mount assembly.
- II. Claims 41-42 relate to a method for mounting electrical connectors in a jack mount.

The "special technical features" of group I relate to a jack, while the "special technical features" of group II relate to a method for mounting electrical connectors in a jack mount. These two groups of inventions are not so linked as to form a single general inventive concept. There is no technical relationship among these inventions involving one or more of the same or corresponding technical features. Thus, the requirement of unity of invention according to Rule 13.1 PCT is not fulfilled.

# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/US 99/26271

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
WO 9638884	A	05-12-1996	AU	2764695 A	18-12-1996
US 4969258	A	13-11-1990	CA	1323978 A	09-11-1993
US 5092029	A	03-03-1992	NONE		

Form PCT/ISA/210 (patent family annex) (July 1992)



CORRECTED VERSION

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
25 May 2000 (25.05.2000)

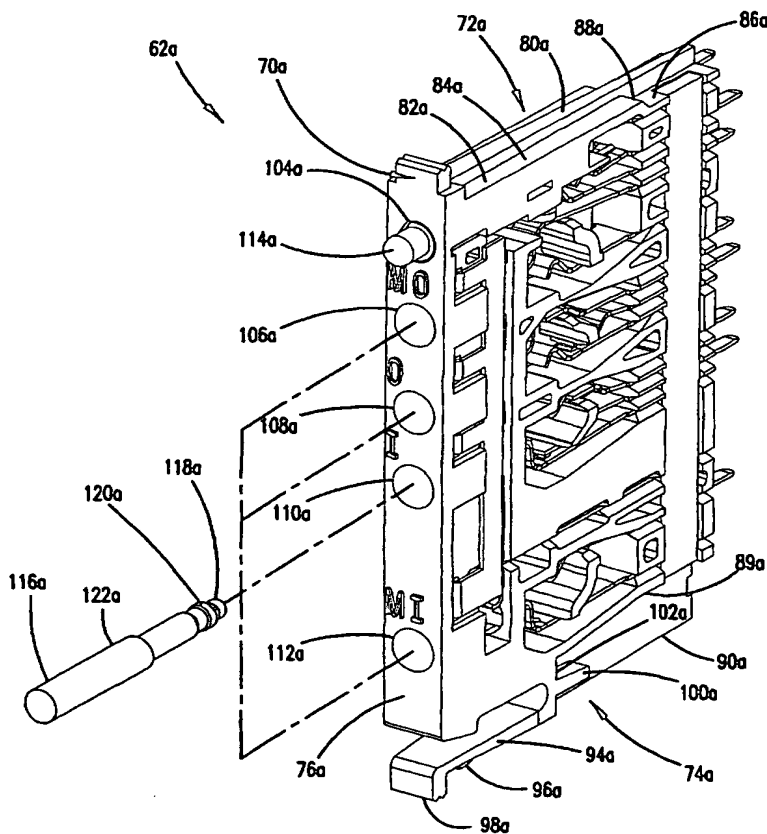
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- (51) International Patent Classification<sup>7</sup>: H04Q 1/14, H01R 12/14, 13/00, 24/04
- (21) International Application Number: PCT/US99/26271
- (22) International Filing Date:  
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09/191,213 12 November 1998 (12.11.1998) US
- (71) Applicant: ADC TELECOMMUNICATIONS, INC.  
[US/US]; 12501 Whitewater Drive, Minnetonka, MN 55343 (US).
- (72) Inventors: HENNEBERGER, Roy, Lee; 12080 Gantry Lane, Apple Valley, MN 55124 (US). DEWEY, James, D.; 5025 Norwood Lane, Plymouth, MN 55442 (US). SA-JADI, Ahmad; 4368 Garden Terrace, Eagan, MN 55123 (US).
- (74) Agent: BRUESS, Steven, C.; Merchant & Gould P.C., 3100 Norwest Center, 90 South Seventh Street, Minneapolis, MN 55402-4131 (US).
- (81) Designated States (*national*): AE, AL, AM, AT, AT (utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, CZ (utility model), DE, DE (utility model), DK, DK (utility model), DM, EE, EE (utility model), ES, FI, FI (utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL,

[Continued on next page]

(54) Title: JACK ASSEMBLY



(57) Abstract: The invention relates to a jack assembly including a jack mount with a jack receiving region. A jack is adapted to be slidably mounted in the jack receiving region. The jack includes a jack body formed of a dielectric material and a plurality of electrically conductive tip and ring springs. The jack body defines a plurality of bores sized to receive plugs having tip and ring contacts. The jack assembly further includes a plurality of cross-connect contacts and a rear interface assembly including a dielectric support. A plurality of rear connectors project outward from the dielectric support, and a circuit board is positioned between the jack mount and the dielectric support. The circuit board provides connections between the cross-connect contacts and the normal contacts. An electrical interface between the jack and the circuit board is configured such that when the jack is removed from the jack mount, the jack is automatically disconnected from the circuit board.



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## JACK ASSEMBLY

### Field of the Invention

The present invention relates generally to cross-connect assemblies  
5 and, in particular, to jack assemblies for digital cross-connect systems.

### Background of the Invention

A digital cross-connect system (DSX) provides a location for  
interconnecting two digital transmission paths. The apparatus for a DSX is located  
10 in one or more frames, or bays, usually in a telephone central office. The DSX  
apparatus also provides jack access to the transmission paths.

DSX jacks are well known and typically include a plurality of bores  
sized for receiving tip-and-ring plugs. A plurality of spring contacts are provided  
within the bores for contacting the tip-and-ring plugs. The jacks are typically  
15 electrically connected to digital transmission lines, and are also electrically  
connected to a plurality of wire termination members used to cross-connect the  
jacks. By inserting plugs within the bores of the jacks, signals transmitted through  
the jacks can be interrupted or monitored.

### Summary of the Invention

20 One aspect of the present invention relates to a jack assembly  
including a jack mount having a front side and a rear side. The jack mount has top  
and bottom supports defining a jack receiving region that opens outward toward the  
front side of the jack mount. A jack of the assembly is adapted to be slidably  
25 mounted in the jack receiving region defined between the top and bottom supports of  
the jack mount. The jack includes a jack body formed of a dielectric material, and a  
plurality of electrically conductive tip and ring springs. The jack body defines a  
plurality of bores sized to receive plugs having tip and ring contacts. The tip springs  
are adapted to make electrical contact with the tip contacts of the plugs when the  
30 plugs are inserted within the bores, and the ring springs are adapted to make  
electrical contact with the ring contacts of the plugs when the plugs are inserted  
within the bores. When plugs are not mounted within the bores, the tip and ring  
springs make electrical contact with normal contacts mounted within the jack. The  
jack assembly also includes a plurality of cross-connect contacts, and a rear  
35 interface assembly. The rear interface assembly includes a dielectric support having  
a first side that faces the jack mount and a second side that faces away from the jack  
mount. A plurality of rear connectors project outward from the second side of the  
dielectric support, and a circuit board is positioned between the jack mount and the

dielectric support. The circuit board is configured to provide electrical connections between the rear connectors and the tip and ring springs. The circuit board also is configured to provide electrical connections between the cross-connect contacts and the normal contacts. The jack assembly further includes a resilient retaining member  
5 connected to one of the jack and the jack mount for securing the jack within the jack mount. The resilient retaining member is moveable between a first position in which the retaining member is adapted to retain the jack within the jack mount, and a second position in which the jack can be inserted into or removed from the jack mount. An electrical interface between the jack and the circuit board is configured  
10 such that when the jack is removed from the jack mount, the jack is electrically disconnected from the circuit board.

Another aspect of the present invention relates to a jack assembly including a jack mount having a front side and a rear side. A jack is positioned at the front side of the jack mount. The jack includes a jack body formed from a  
15 dielectric material. The jack body defines a plurality of bores each sized to receive a plug having a tip contact and a ring contact. The jack also includes a plurality of electrically conductive tip-and-ring springs. The tip springs are adapted to make electrical contact with the tip contacts of the plugs when the plugs are inserted within the bores, and the ring springs are adapted to make electrical contact with the  
20 ring contacts of the plugs when the plugs are inserted within the bores. The jack further includes a plurality of normal contacts adapted to normally make electrical contact with the tip-and-ring springs. A plurality of cross-connect contacts are electrically connected to the normal contacts of the jack. The jack assembly also includes first and second rear interface assemblies that can selectively be secured  
25 adjacent to the rear side of the jack mount. The first rear interface assembly includes a plurality of wire termination members that are electrically connected to the tip-and-ring springs when the first rear interface assembly is secured to the jack mount. The second rear interface assembly includes a plurality of coaxial connectors. The coaxial connectors are electrically connected to baluns that are electrically connected  
30 to the tip-and-ring springs when the second rear interface assembly is secured to the jack mount. The first and second rear interface assemblies allow a single common universal jack mount to interface either with standard twisted pair signal lines, or coaxial signal lines.

A further aspect of the present invention relates to a jack assembly  
35 including a jack mount having a front side and a rear side, and a jack positioned at the front side of the jack mount. The jack includes a jack body formed of a dielectric material. The jack body defines a plurality of bores each sized to receive a plug having a tip contact and a ring contact. The jack also includes a plurality of



electrically conductive tip and ring springs. The tip springs are adapted to make electrical contact with the tip contacts of the plugs when the plugs are inserted within the bores, and the ring springs are adapted to make electrical contact with the ring contacts of the plugs when the plugs are inserted within the bores. The jacks further include a plurality of normal contacts adapted to normally make electrical contact with the tip-and-ring springs. A plurality of cross-connect contacts are electrically connected to the normal contacts of the jack. A rear interface assembly is positioned at the rear side of the jack mount. The rear interface assembly includes a dielectric support having a first side that faces the jack mount and a second side that faces away from the jack mount. The rear interface assembly further includes a plurality of baluns supported by the dielectric support, and a plurality of coaxial connectors that project outward from the second side of the support and are electrically connected to the baluns. Contact members, that are electrically connected to the baluns, project outward from the first side of the support. The contact members provide an electrical connection between the baluns and a circuit board. The circuit board provides electrical connections between the contact members and the tip and ring springs of the jack, and also provides electrical connections between the cross-connect contacts and the normal contacts of the jack.

A variety of advantages of the invention will be set forth in part in the description that follows, and in part will be apparent from the description, or may be learned by practicing the invention. It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the invention as claimed.

#### Brief Description of the Drawings

The accompanying drawings, which are incorporated in and constitute a part of the description, illustrate several aspects of the invention and together with the description, serve to explain the principles of the invention. A brief description of the drawings is as follows:

FIG. 1 is an exploded view of a chassis constructed in accordance with the principles of the present invention;

FIG. 2 is a front perspective view of a jack in accordance with the principles of the present invention;

FIG. 3 is a rear perspective view of the jack of FIG. 2;

FIG. 4 is a side view of the jack of FIG. 2;

FIG. 5 is a front perspective view of an another jack in accordance with the principles of the present invention;

FIG. 6 is a rear perspective view of the jack of FIG. 5;

FIG. 7 is a side view of the jack of FIG. 5;  
FIG. 8 is a front perspective view of jack mount in accordance with the principles of the present invention;  
FIG. 9 is a front view of a portion of the jack mount of FIG. 8;  
5 FIG. 10 is a cross-sectional view taken along section line 10-10 of FIG. 9;  
FIG. 11 is a cross-sectional view taken along section line 11-11 of FIG. 9;  
FIG. 12 is a rear perspective view of the jack mount of FIG. 8;  
10 FIG. 13 is a rear view of the jack mount of FIG. 8;  
FIG. 14 is an assembly view of the jack mount of FIG. 8;  
FIG. 15 is a front exploded view of a jack mount and twisted pair rear interface assembly in accordance with the principles of the present invention;  
15 FIG. 16 is a rear exploded view of the jack mount and twisted pair rear interface assembly of FIG. 15;  
FIG. 17 is a side assembled view of the jack mount and twisted pair rear interface assembly of FIG. 15;  
FIG. 18 is a schematic circuit diagram corresponding to the jack mount and twisted pair rear interface assembly of FIG. 15;  
20 FIG. 19 is a front exploded view of a jack mount and coaxial rear interface assembly in accordance with the principles of the present invention;  
FIG. 20 is a rear perspective view of the coaxial rear interface assembly of FIG 19;  
FIG. 21 is an exploded view of a connector constructed in accordance with the principles of the present invention;  
25 FIG. 22 is an assembled side view of the connector of FIG. 21;  
FIG. 23 is a cross-sectional view taken along section line 23-23 of FIG. 22;  
FIG. 24 is an exploded view of another connector constructed in accordance with the principles of the present invention;  
30 FIG. 25 is an assembled side view of the connector of FIG. 24;  
FIG. 26 is a cross-sectional view taken along section line 26-26 of FIG. 25;  
FIG. 27 is an exploded view of the coaxial rear interface assembly of 35 FIG. 20;  
FIG. 28 is a rear view of the coaxial rear interface assembly of FIG. 20;  
FIG. 29 is an enlarged view of a portion of FIG. 28; and

FIG. 30 is an enlarged view of another portion of FIG. 28.

### Detailed Description

Reference will now be made in detail to exemplary aspects of the present invention which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

#### I. Chassis assembly

Figure 1 is an exploded view of an embodiment of a chassis 20 for housing a plurality of jack mounts 22. For clarity, only two jack mounts 22 are shown in figure 1. However, it will be appreciated that the chassis 20 is adapted for housing a plurality of jack mounts 22. To conform with conventional international standards, the chassis 20 can house 16 jack mounts 22 and have a length of about 19 inches. Alternatively, in accordance with standard United States specifications, the chassis could be configured to house 21 jacks and have a length of about 23 inches. Of course, other sizes and numbers of jack mounts could also be used.

The chassis 20 includes a top piece 24 positioned opposite from a bottom piece 26. The top and bottom pieces 24 and 26 are interconnected by left and right side walls 28 and 30. The chassis 20 also includes a front side 32 positioned opposite from a back side 34. The top piece 24 includes separate front and back components 23 and 25. The front component 23 is connected to the chassis 20 by fasteners (e.g., screws) that extend through a front lip 27 of the front component 23 and engage front tabs 29 provided on the side walls 28 and 30. The rear component 25 is connected to the chassis 20 by fasteners (e.g., screws) that extend downward through top tabs 31 provided on the side walls 28 and 30. The rear component 25 defines a recessed lip 35 for receiving a rear portion of the front component 23 to form a joint thereinbetween. The removable front component 23 assists in inserting or removing the jack mounts 22 into or from the chassis 20.

A wire tray door 36 is connected to the bottom piece 26 adjacent the front side 32 of the housing 20. A hinge 37 allows the door 36 to pivot between horizontal and vertical orientations. Latches 39 hold the door 36 in the vertical orientation. Additionally, a rear flange 38 projects upward from the bottom piece 26 adjacent the back side 34 of the chassis 20. The rear flange 38 defines a plurality of notches or cutaway portions 40. A plurality of mounting flanges 42 project upward from the bottom piece 26 between the front and back sides 32 and 34 of the chassis 20. The mounting flanges 42 are adapted for connecting the jack mounts 22 to the chassis 20. For example, the mounting flanges 42 are shown including holes for allowing the jack mounts 22 to be screwed or bolted to the mounting flanges 42.

The mounting flanges 42 define cutaway portions 44 that correspond to alternating ones of the cutaway portions 40 defined by the rear flange 38.

5 Cover members 46 are positioned between the mounting flanges 42 and the rear flange 38. The cover members 46 define recesses 48 that align with the cutaway portions 40 and 44 respectively defined by the rear flange 38 and the mounting flanges 42. The cover members 46 function to conceal screws or other types of connecting members used to connect the jack mounts 22 to the mounting flanges 42. When coaxial rear interfaces (described later in the specification) are used in combination with the jack mounts 22, the cutaway portions 40 and 44 and the recesses 48 provide clearance for allowing the coaxial connectors to be accessed. 10 In this manner, the height of the chassis 20 can be minimized while still providing access to the lowermost coaxial connectors.

The chassis 20 also includes a cover plate 50 connected below the top piece 24 of the chassis 20. A power strip 52 is connected to the front cover plate 50. 15 The power strip 52 includes a plurality of electrical receptacles 54 electrically connected to a main power connector 56. The receptacles 54 align with and are set behind alignment openings 58 defined by the cover plate 50.

As shown in figure 1, the jack mount 22 is part of a jack assembly including odd jacks 62a, even jacks 62b, and a rear interface assembly 64. The rear 20 interface assembly 64 includes a dielectric support 66, and a circuit board 68 positioned between the dielectric support 66 and the jack mount 22. The odd and even jacks 62a and 62b preferably have different configurations such that when the jacks 62a and 62b are mounted within the jack mount 22, plug bores defined by the jacks 62a and 62b are vertically staggered relative to one another.

## 25 II. Odd Jack Configuration

Figures 2-4 illustrate one of the odd jacks 62a in isolation from the jack mount 22. The jack 62a includes a dielectric jack body 70a. The dielectric jack body 70a includes a top side 72a and a bottom side 74a arranged and configured to slidingly interface with the jack mount 22. The jack body 70a also includes a front 30 side 76a positioned opposite from a back side 78a. The top side 72a of the jack body 70a includes an elongated guide member 80a that extends between the front and back sides 76a and 78a of the jack body 70a. As best shown in figure 3, the guide member 80a tapers laterally outward as it extends from the back side 78a toward the front side 76a. Guide surfaces 82a are positioned on opposite sides of the guide 35 member 80a. The guide surfaces 82a include substantially parallel front and rear portions 84a and 86a. The front and rear portions 84a and 86a are interconnected by ramped portions 88a such that the front portions 84a are elevated relative to the rear portions 86a.

The bottom side 74a of the jack body 70a includes a guide member 90a that extends between the back side 78a of the jack body 70a and a transverse wall 92a. The guide member 90a tapers laterally outward as it extends from the back side 78a toward the transverse wall 92a. The transverse wall 92a forms a base  
5 end of a cantilevered locking member 94a that extends from the transverse wall 92a toward the front side 76a of the jack body 70a. A locking tab 96a projects downward from the locking member 94a. A gripping member 98a projects downward from a free end of the locking member 94a. The locking member 94a preferably has a resilient or elastic structure such that the locking member 94a can  
10 be flexed upward by pressing upward on the gripping member 98a. By flexing the locking member 94a, the locking member 94a can be moved between a retaining position  $P_{a1}$  (shown in Figure 4) and a non-retaining position  $P_{a2}$ .

The bottom side 74a additionally includes alignment members 100a that project laterally outward from opposite sides of the guide member 90a. The  
15 alignment members 100a are also connected to the transverse wall 92a and at least partially define alignment notches 102a positioned above the alignment members 100a. Guide surfaces 89a are positioned above notches 102a and include front and rear portions 91a and 93a interconnected by a ramped portion 95a. The rear portions 93a are elevated relative to the front portions 91a.

As best shown in figure 2, the front side 76a of the jack body 70a is generally planar and defines a light emitting diode (LED) port 104a, a monitor out port 106a, an out port 108a, an in port 110a, and a monitor in port 112a. The LED  
20 port 104a is sized for receiving an LED 114a. Each of the other bores 106a, 108a, 110a and 112a is sized to receive a standard tip-and-ring plug 116a of known  
25 dimensions. The plug 116a includes a tip contact 118a, a ring contact 120a and a cylindrical sleeve 122a.

As shown in figure 3, the back side 78a of the jack body 70a is formed by a generally planar surface 124a that is generally parallel with respect to the front side 76a. The planar back surface 124a defines a plurality of back slots  
30 126a each having a generally rectangular shape.

Referring now to figure 4, the jack body 70a also defines a monitor out chamber 128a, an out chamber 130a positioned below the monitor out chamber 128a, an in chamber 132a positioned below the out chamber 130a, and a monitor in chamber 134a positioned below the in chamber 132a.

35 The monitor out chamber 128a is in communication with both the LED port 104a and the monitor out port 106a. The LED 114a is mounted within the LED port 104a and includes first and second leads 136a and 138a that project into the monitor out chamber 128a. The first lead 136a is contacted by an electrically

conductive voltage spring 141a, and the second lead 138a contacts an electrically  
conductive tracer lamp spring 142a. Electrically conductive tip-and-ring springs  
145a and 144a are positioned within the monitor out chamber 128a in general  
alignment with the monitor out port 106a. The ring spring 144a and the tip spring  
5 145a are separated by a dielectric spacer 182a that is integrally formed with the jack  
body 70a. A LED return spring 143a is positioned between the ring spring 144a and  
the tracer lamp spring 142a. When the tip-and-ring plug 116 is inserted within the  
monitor out port 106a, the ring spring 144a is flexed upwardly while the tip spring  
145a is flexed downwardly. The ring spring 144a contacts the ring contact 120a,  
10 and the tip spring 145a contacts the tip contact 118a of the plug 116a. When the ring  
spring 144a is flexed upward, it causes the LED return spring 143a to contact the  
second lead 138a of the LED 114a thereby illuminating the LED 114a. A dielectric  
pad 184a attached to the ring spring 144a prevents the ring spring 144a from  
electrically contacting the LED return spring 143a.

15               The out chamber 130a is in communication with the out port 108a.  
Electrically conductive tip-and-ring springs 149a and 146a are positioned within the  
out chamber 130a in general alignment with the out port 108a. The tip-and-ring  
springs 149a and 146a are normally in electrical contact with the respective  
electrically conductive normal springs 148a and 147a. The normal springs 147a and  
20 148a are separated by a dielectric spacer 184a that is integrally formed with the jack  
body 70a. When the plug 116a is inserted within the out port 108a, ring spring 146a  
is disconnected from normal spring 147a and electrically contacts the ring contact  
120a of the plug 116a. Concurrently, tip spring 149a is disconnected from normal  
spring 148a and electrically contacts the tip contact 118a of the plug 116a.

25               The in chamber 132a is in communication with the in port 110a.  
Electrically conductive tip-and-ring springs 150a and 153a are positioned within the  
in chamber 132a in general alignment with the in port 110a. The tip-and-ring  
springs 150a and 153a are normally in electrical contact with respective electrically  
conductive normal springs 151a and 152a. Normal springs 151a and 152a are  
30 separated by a dielectric spacer 186a that is integrally formed with the jack body  
70a. When the plug 116a is inserted within the in port 110a, the tip-and-ring springs  
150a and 153a are respectively disengaged from the normal springs 151a and 152a,  
and respectively make electrical contact with the tip-and-ring contacts 118a and  
120a of the plug 116a.

35               An electrically conductive sleeve ground spring 154a is positioned  
between the in chamber 132a and the monitor in chamber 134a. The ground spring  
154a is electrically connected to a grounding strip 188a that has electrical contacts  
corresponding to each of the ports 106a, 108a, 110a and 112a. The contacts are

configured to engage the sleeve 122a of the plug 116a when the plug is inserted within the ports 106a, 108a, 110a and 112a.

The monitor in chamber 134a of the jack body 70a is in communication with the monitor in port 112a. Electrically conductive tip-and-ring springs 155a and 156a are positioned within the monitor in chamber 134a in general alignment with the monitor in port 112a. A dielectric spacer 190a is positioned between the tip-and-ring springs 155a and 156a. When the plug 116a is inserted within the monitor in port 112a, the tip spring 155a makes electrical contact with the tip contact 118a and the ring spring 156a makes electrical contact with the ring contact 120a.

Referring to Figure 4, the springs 141a-156a are preferably held within the jack body 70a by a dielectric strip 191a. The dielectric strip 191a is preferably press-fit or snapped within a corresponding slot defined by the jack body 70a.

As best shown in figure 3, electrically conductive springs 141a-156a each include portions 141a'-156a' that extend through the slots 126a defined by the back side 78a of the jack body 70a. The portions 141a'-156a' project outward from the back side 78a and form generally flat contact members adapted for electrically connecting the springs 141a-156a to a desired structure. As shown in Figure 4, the portions 141a'-156a' have projection lengths that vary such that the tips of the portions 141a'-156a' are staggered. The staggered tips reduce the insertion force required to connect the jack 62a to a desired structure because all of the tips do not engage the desired structure simultaneously upon insertion.

### III. Even Jack Configuration

Figures 5-7 illustrate one of the even jacks 62b in isolation from the jack mount 22. The jack 62b includes a dielectric jack body 70b having a top side 72b positioned opposite from a bottom side 74b, and a front side 76b positioned opposite from a back side 78b. The top side 72b includes a laterally tapered guide member 90b, and a resilient locking member 94b having an upwardly projecting locking tab 96b. The locking member 94b can be flexed between a retaining position  $P_{b1}$  and a non-retaining position  $P_{b2}$ . A transverse wall 92b is positioned generally between the locking member 94b and the guide member 90b. Alignment notches 102b are formed generally below the transverse wall 92b on opposite sides of the guide member 90b. Guide surfaces 89b are positioned below the notches 102b on opposite sides of the guide member 90b. The guide surfaces 89b include front portions 91b elevated relative to rear portions 93b, and ramped portions 95b positioned between the front and rear portions 91b and 93b.

The bottom side 74b of the jack body 70b includes an elongated guide member 80b extending between the front and back sides 76b and 78b. The guide member 80b tapers laterally outward as it extends from the back side 78b toward the front side 76b. The bottom side 74b also includes guide surfaces 82b positioned on opposite sides of the guide member 80b. The guide surfaces 82b include substantially parallel front and back portions 84b and 86b. A ramped portion 88b interconnects the front and back portions 84b and 86b such that the back portions 86b are elevated relative to the front portions 84b.

It will be appreciated that the top and bottom sides 72b and 74b of the jack body 70b have different configurations than the top and bottom sides 72a and 74a of the jack body 70a. Preferably, the top and bottom sides of the jack bodies 70a and 70b have varying configurations in order to provide a keying function. For example, by varying the configurations of the top and bottom sides of the jack bodies 70a and 70b, a user is prevented from placing the jacks 62a and 62b in the wrong positions on the jack mount 22. The user is also inhibited from inserting the jacks 62a and 62b upside-down into the jack mount 22.

As shown in Figure 5, the front side 76b of the jack body 70b defines an LED port 104b, a monitor out port 106b, an out port 108b, an in port 110b, and a monitor in port 112b. It will be appreciated that the ports 104b, 106b, 108b, 110b and 112b are arranged in a different pattern than the ports 104a, 106a, 108a, 110a and 112a. For example, a larger spacing exists between the monitor out port 106b and the out port 108b as compared to the monitor out port 106a and the out port 108a. Additionally, a reduced spacing exists between the in port 110b and the monitor in port 112b as compared to the in port 110a and the monitor in port 112a. It will be appreciated that the terms "port" and "bore" are intended to be used interchangeably.

The jack 62b has similar internal components to those previously described with respect to the jack 62a. For example, the jack 62b includes an LED 114b electrically connected to a voltage spring 141b and a tracer lamp spring 142b by leads 136b and 138b. An LED ground spring 143b is used to complete the circuit and light the LED 114b. The jack 62b also includes tip-and-ring springs 145b and 144b corresponding to the monitor out port 106b, tip-and-ring springs 149b and 146b corresponding to the out port 108b, tip and ring springs 150b and 153b corresponding to the in port 110b and tip-and-ring springs 155b and 156b corresponding to the monitor in port 112b. The ring-and-tip springs 146b and 149b normally contact respective normal springs 147b and 148b, and tip-and-ring springs 150b and 153b normally contact respective normal springs 151b and 152b. The jack 62b also includes a sleeve ground spring 154b interconnected to a grounding strip



188b having sleeve contacts corresponding to each of the ports 106b, 108b, 110b and 112b. The conductive springs 141b-156b each include end portions 141b'-156b' (best shown in figure 6) that project outward from the back side 78b of the jack body 70b so as to form electrical contact members. As shown in Figure 7, the tips of the  
5 end portions 141a'-156a' are staggered.

#### IV. The Jack Mount

Referring now to figure 8, the jack mount 22 is shown in isolation from the chassis 20 with the jacks 62a and 62b removed. Generally, the jack mount 22 includes a mounting body 200 made of a dielectric material. The mounting body  
10 200 includes a jack receiving piece 202 that can be detachably connected to a cross-connect piece 204. As will be described in greater detail below, the jack receiving piece 202 is adapted for housing or holding the jacks 62a and 62b, while the cross-connect piece 204 is adapted for providing cross-connects between jacks.

The jack receiving piece 202 of the mounting body 200 includes a  
15 front side 206 positioned opposite from a back side 208. The piece 202 also includes spaced-apart and substantially parallel top and bottom supports 210 and 212 that extend generally between the front and back sides 206 and 208. The top and bottom supports 210 and 212 are interconnected by a back wall 214 of the jack receiving piece 202. The top support 210, the bottom support 212 and the back wall  
20 214 cooperate to define a jack mounting region or recess that opens outward toward the front side 206 of the upper piece 202.

As shown in figure 9, the jack receiving piece 202 of the mounting body 200 defines four separate jack mounting locations  $ML_1$ ,  $ML_2$ ,  $ML_3$  and  $ML_4$ . Jack mounting locations  $ML_1$  and  $ML_3$  are adapted to receive the odd jacks 62a,  
25 while mounting locations  $ML_2$  and  $ML_4$  are adapted for receiving the even jacks 62b.

Mounting locations  $ML_1$  and  $ML_3$  each include top and bottom channels 224 and 226 respectively formed on the top support 210 and the bottom support 212. The top and bottom channels 224 and 226 are configured to respectively complement the top and bottom sides 72a and 74a of the jacks 62a. For  
30 example, referring to figure 10, the top channels 224 are tapered so as to compliment or match the taper of the guide members 80a formed on the top sides 72a of the jack bodies 70a. Additionally, the walls forming the top channels 224 have downwardly facing guide surfaces 228 including front portions 230, rear portions 232 and ramped portions 234 that respectively correspond to and complement the front portions 84a,  
35 rear portions 86a and ramped portions 88a of the guide surfaces 82a positioned along the top side 72a of the jack body 70a.

As shown in figure 11, the bottom channels 226 are tapered so as to complement or correspond to the taper of the guide member 90a positioned at the

bottom side 74a of the jack body 70a. The bottom channels 226 also include end projections 236 adapted to mate with or fit within the alignment notches 102a formed adjacent the bottom side 74a of the jack body 70a. The walls forming the channels 226 have upwardly facing guide surfaces 223 including front, rear and  
5 ramped portions 225, 227 and 229 that respectively complement the front, rear, and ramped portions 91a, 93a and 95a of the guide surfaces 89a formed on the bottom side of each jack 62a.

The jack 62a is mounted within one of the mounting locations  $ML_1$  and  $ML_3$  by inserting the rear ends of the guide members 80a and 90a respectively  
10 within the top and bottom channels 224 and 226. The jack 62a is then pushed inward toward the back wall 214 of the jack receiving piece 202 causing the guide members 80a and 90a to respectively slide along the top and bottom channels 224 and 226. When the jack 62a has been fully inserted into the jack receiving piece 202, the locking tab 96a of the resilient locking member 94a snaps within a hole 238  
15 (shown in figure 11) defined by the bottom support 212. To remove the jack 62a from the jack mount 22, the resilient locking member 94a is flexed from the retaining position  $P_{a1}$  to the non-retaining position  $P_{a2}$  such that the locking tab 96a is displaced from the hole 238. The jack 62a can then be manually pulled out from the jack receiving piece 202.

Jack mounting locations  $ML_2$  and  $ML_4$  each define top and bottom  
20 channels 240 and 242 respectively formed on the top support 210 and the bottom support 212. The top channels 240 are configured to complement the shape of the top side 72b of the jack 62b. For example, the top channels 240 are tapered so as to complement the taper of the guide member 90b formed on the top side 72b of the  
25 jack 62b. As shown in Figure 10, the top channels 240 also include projections 244 adapted to fit within the alignment notches 102b formed on the jack body 70b adjacent the top side 72b. Furthermore, the walls defining the top channel 240 include downwardly facing guide surfaces 246 including front portions 248, rear  
30 portions 250 and ramped portions 252 that respectively complement the front, rear and ramped portions 91b, 93b and 95b of the guide surfaces 89b formed on the top side 72b of the jack body 70b. It is further noted that the top support 210 defines openings 254 arranged and configured to receive the locking tab 96b of the jack body 70b when the jack 62b is mounted within the jack mount 22.

The bottom channels 242 are each configured to compliment the  
35 bottom side 74b of the jack body 70b. For example, as shown in figure 11, the bottom channels 242 are tapered to correspond with the taper of the guide member 80b formed on the bottom side 74b of the jack body 70b. Additionally, the walls defining the bottom channels 242 include guide surfaces 256 having front, rear and

ramped portions 258, 260 and 262 arranged and configured to respectively complement the front, rear and ramped portions 84b, 86b and 88b of the guide surfaces 82b formed on the bottom side 74b of the jack body 70b.

The top and bottom channels 224, 226 of mounting locations  $ML_1$  and  $ML_3$ , and the top and bottom channels 240, 242 of mounting locations  $ML_2$  and  $ML_4$  have been designed in coordination with the top and bottom sides of the jacks 62a and 62b in order to provide a keying function. For example, the jack 62a can only be mounted in the jack mount 22 if it is oriented in an upright position and is inserted into either one of the jack mounting locations  $ML_1$  and  $ML_3$ . Interference between the top and bottom sides of the jack 62a and the top and bottom channels 240 and 242 prevents the jack 62a from being inserted into either one of mounting locations  $ML_2$  and  $ML_4$ . Similarly, the even jack 62b can only be mounted at mounting locations  $ML_2$  and  $ML_4$ . If the user attempts to insert the jack 62b into either of the jack mounting locations  $ML_1$  and  $ML_3$ , the jack 62b will bind with the top and bottom channels 224 and 226 thereby preventing the jack 62b from being fully inserted into the jack mount 22.

As shown in figure 9, mounting locations  $ML_1$  and  $ML_3$  each include a corresponding pattern or array of openings 264 defined through the back wall 214 of the jack receiving piece 202 of the mounting body 200. The openings 264 are configured to receive the spring ends 141a'-156a' that project outward from the back side 78a of each jack 62a. Similarly, each of mounting locations  $ML_2$  and  $ML_4$  includes a corresponding pattern or array of openings 266 formed through the back wall 214 of the jack receiving piece 202 of the mounting body 200. The openings 266 are configured to receive the spring ends 141b'-156b' that project outward from the back side 78b of each jack 62b.

Referring to figure 12, the openings 264 and 266 extend completely through the back wall 214. Connection pins 268 are mounted within each of the openings 264 and 266. As shown in figure 14, each of the connection pins 268 includes a pin portion 270 that projects outward from the back side 208 of the jack receiving piece 202, and two opposing, cantilevered contact members 272 that are press fit within the openings 264 and 266. In the assembly view of figure 14, the connection pins 268 are shown connected to elongated installation tools 274 (e.g., the connection pins 268 and the installation tools 274 have been stamped from a common strip of conductive material). The installation tools 274 maintain a vertical spacing between the connection pins 268 that corresponds to the vertical spacing of the openings 264 and 266. For example, the installation tools 274 labeled A and B align the connection pins 268 in a pattern that corresponds to the pattern defined by the openings 264. The installation tools 274 labeled C and D align the connection

pins 268 in a pattern that corresponds to the pattern defined by the openings 266. The installation tools 274 are used to press multiple pins 268 in the openings 264 and 266 at once. After the pins have been pressed within the openings 264 and 266, the tools 274 are laterally twisted causing the pins to break-off within the openings 264 and 266.

When the jacks 62a are mounted within the jack mount 22, the spring extensions 141a'-156a' fit within the openings 264 and are compressed between the opposing contact members 272 of the connection pins 268 such that the spring contacts 141a-156a are electrically connected to the pins 268. Similarly, when the jacks 62b are mounted within the jack mount 22, the spring extensions 141b'-156b' fit within the openings 266 and are compressed between the opposing contact members 272 of the connection pins 268 to provide an electrical interface between the jack springs 141b-156b and the connection pins 268. The variable lengths of the spring extensions 141a'-156a' and 141b'-156b' assist in reducing the insertion force required to press the spring extensions between the contact members 272.

Referring back to figure 8, the cross-connect piece 204 of the mounting body 200 is adapted for providing cross-connections between jacks. For example, four columns ( $C_1$ - $C_4$ ) and five rows ( $R_1$ - $R_5$ ) of wire termination members 276 (e.g., wire wrap members or posts) are shown projecting outward from a front face 278 of the piece 204. It will be appreciated that the removability of the cross-connect piece 204 from the jack receiving piece 202 is significant because different types of wire termination members or contacts can be used to provide cross-connections. For example, for certain applications, it may be desired to use insulation displacement connectors (IDC) for providing cross-connections between jacks. By using cross-connect pieces 204 that are separate from the jack mounting portion 202, cross-connect pieces having different types of connectors can be used with the common base to enhance manufacturing efficiency. While wire wrap members and insulation displacement connectors have been specifically described, it will be appreciated that other types of connectors could also be used.

To provide a detachable interface between the jack receiving piece 202 and the cross-connect piece 204, the cross-connect piece 204 includes two spaced-apart tongues 280 (shown in figure 8) that are slidably received within corresponding spaced-apart grooves 282 (shown in figure 13) defined by the jack receiving piece 202. To connect the cross-connect piece 204 to the jack-receiving piece 202, the tongues 280 are aligned with the grooves 282 and the cross-connect piece 204 is slid from the back side 208 of the jack receiving piece 202 toward the front side 206. The tongues 280 are slid along the grooves 282 until the front face 278 of the cross-connect piece 204 engages a shoulder 284 defined by the piece 202.

When the cross-connect piece 204 engages the shoulder 284, an upwardly projecting tab 286 (shown in figure 8) formed on the cross-connect piece 204 snaps within a locking opening 288 (shown in figure 14) defined by a resilient clip 290 formed at the bottom of the jack receiving piece 202. To remove the cross-connect piece 204 from the jack-receiving piece 202, the clip 290 is flexed upwardly such that the tab 286 disengages from the opening 288, and the lower piece 204 is pulled in a rearward direction from the upper body 202.

#### V. Twisted Pair Rear Interface

Figure 15 illustrates the dielectric support 66 of the rear interface assembly 64 removed from the circuit board 68. The dielectric support 66 includes a front side 300 adapted to face the circuit board 68, and a back side 302 adapted to face away from the circuit board 68. As shown in figure 16, the rear interface assembly 64 also includes four columns ( $C_a$ - $C_d$ ) and four rows ( $R_a$ - $R_d$ ) of wire termination members 304 press fit within holes defined by the dielectric support 66. The wire termination members 304 are shown as wire wrap members. However, it will be appreciated that other types of wire termination members such as insulation displacement connectors could also be used.

Referring to figure 16, the wire termination members 304 are adapted to contact plated through-holes 306 in the circuit board 68. Similarly, the wire termination members 276 of the jack mount 22 connect with plated through-holes 308 in the circuit board 68. The plated through-holes 306 are oriented in rows that are positioned between rows  $R_1$ - $R_3$ . The circuit board 68 also includes a plurality of additional plated through-holes 310 positioned to make electrical contacts with the connector pins 268 that project outward from the back wall 214 of the jack mount upper piece 202 (shown in figure 12).

The dielectric support 66 of the rear interface assembly 64 defines a protective receptacle 318 in which a voltage lead 312, a return lead 314 and a sleeve ground lead 316 are mounted. The receptacle 318 is adapted to interconnect with the receptacles 54 formed on the power strip 52 of the chassis 20. When the jacks 62a and 62b are mounted within the jack mount 22, the voltage springs 141a, 141b of the jacks are placed in electrical connection with the voltage leads 312, the return spring 143a, 143b of the jacks 62a, 62b are placed in electrical connection with the return leads 314, and the ground springs 154a, 154b of the jacks 62a, 62b are placed in electrical connection with the shield ground leads 316.

Referring to figure 17, when the jack assembly 60 is assembled, the printed circuit board 68 is positioned between the jack mount 22 and the dielectric support 66 (the jacks of the assembly are not shown in Figure 17). The circuit board 68 includes a plurality of circuit paths for electrically connecting selected ones of the

connection pins 268 to the receptacle leads 312, 314 and 316, to the wire termination members 304 of the rear interface assembly 64, and to the cross-connect wire termination members 276. The single circuit board 68 is adapted for connecting all four jacks 62a and 62b (shown in figure 1) to the leads 312, 314 and 316, and to the  
5 their corresponding columns of rear interface wire termination members 304 and cross-connect wire termination members 276. When the jacks 62a and 62b are removed from the jack mount 22, the jacks 62a and 62b are disconnected from the circuit board 68.

As shown in figures 15 and 16, the circuit board 68, the jack mount  
10 22 and the dielectric support 66 define coaxially aligned openings sized to receive fasteners 69 (e.g., bolts or screws) for connecting the pieces together. The fasteners 69 extend through captivation washers 71 that are press-fit over the fasteners 69. The captivation washers 71 and the fasteners 69 hold the jack mount 22, the circuit board 68 and the dielectric support 66 together after assembly and inhibit the pieces  
15 from being unintentionally pulled apart prior to connection to the chassis 20. The assembly 60 is connected to the chassis 20 by threading the fasteners within holes defined by the chassis 20 (e.g., holes defined by the flanges 42 and the coverplate 50 of the chassis 20).

In use of the jack assembly 60, columns  $C_1$ - $C_4$  of cross-connect wire termination member 276 are respectively connected to jacks positioned in mounting locations  $ML_1$ - $ML_4$ . The wire termination members 276 of row  $R_1$  are tracer lamp contacts (TL), the wire termination members 276 of row  $R_2$  are cross-connect tip-out contacts (XTO), the wire termination members 276 of row  $R_3$  are cross-connect ring-out contacts (XRO), the wire termination members 276 of row  $R_4$  are cross-connect  
20 tip-in contacts (XTI), and the wire termination members 276 of row  $R_5$  are cross-connect ring-in contacts (XRI).

Columns  $C_a$ - $C_d$  of the IN/OUT termination members 304 are respectively in electrical contact with jacks inserted within jack mounting locations  $ML_1$ - $ML_4$ . The wire termination members 304 of row  $R_a$  are tip-out contacts (TO),  
30 the wire termination members 304 forming row  $R_b$  are ring-out contacts (RO), the wire termination members 304 forming row  $R_c$  are tip-in contacts (TI), and the wire termination members 304 forming row  $R_d$  are ring-in contacts (RI).

Figure 18 is a circuit diagram illustrating the electrical connections made when one of the jacks 62b is inserted within jack mounting location  $ML_4$ . It  
35 will be appreciated that similar electrical configurations are used to interconnect jacks placed in mounting locations  $ML_1$ - $ML_3$  with the corresponding columns of contacts  $C_1$ - $C_3$  and  $C_a$ - $C_c$ .

Referring to figure 18, the voltage spring 141b is electrically connected to an energized contact point (e.g., the voltage lead 312) for illuminating the LED. The tracer lamp spring 142b is connected to the tracer lamp contact TL of column C<sub>4</sub>. The return spring 143b is connected to the return lead 314. The shield ground spring 154b is connected to the shield ground lead 316. The out ring spring 146b is connected to the ring-out contact RO by circuit path 404. The ring normal spring 147b is connected to the cross-connect ring-out contact XRO of column C<sub>4</sub>. The tip normal spring 148b is connected to the cross-connect tip-out contact XTO of column C<sub>4</sub>. Tip spring 149b is connected to the tip-out contact TO of column C<sub>4</sub> by circuit path 406. The monitor out ring spring 144b is connected to circuit path 404, and the monitor out tip spring 145b is connected to circuit path 406. Tip spring 150b is connected to the tip-in contact TI of column C<sub>4</sub> by circuit path 408. Tip normal spring 151b is connected to the cross-connect tip-in contact XTI of column C<sub>4</sub>, and ring normal spring 152b is electrically connected to the cross-connect ring-in contact XRI of column C<sub>4</sub>. Ring spring 153b is connected to the ring-in RI contact of column C<sub>4</sub> by circuit path 410. Tip spring 155b is connected to circuit path 408, while ring spring 156b is connected to circuit path 410.

Cross-connection of a signal from another jack arrives as an IN signal from cross-connect tip-in and ring-in contacts XTI and XRI of column C<sub>4</sub>. With no plug inserted within the in port 110b, the IN signal is output at the tip-in and ring-in contacts TI and RI of column C<sub>4</sub>.

By inserting a plug within the in port 110b, the IN signal from a cross-connected jack can be interrupted and a signal from the inserted plug can be outputted at points TI and RI. Similarly, by inserting a plug within the out port 108b, the OUT signal from contact points TO and RO is interrupted and may be outputted to the tip-and-ring contacts of the plug inserted within the out port 108b.

Frequently it is desirable to be able to monitor OUT signals arriving through contacts TO and RO without interrupting the OUT signals. To accomplish this, a plug is inserted into the monitor port 106b. On this occurrence, the plug is able to tap into the OUT signals being transmitted through circuit paths 404 and 406. Additionally, when the plug is inserted into the port 106b, the return spring 143b is biased upward into contact with the second lead 138b of the tracer lamp 114b. The electrical connection between the second lead 138b and the return spring 143b connects the LED circuit to the return line 314 thereby illuminating the LED. Integrated circuit chip 184b controls flashing of the LED 114b as is conventionally known in the art. In addition to activating the LED, insertion of a plug into the monitor port 106b also grounds the tracer lamp line TL causing illumination of a LED on a jack to which the present jack is cross-connected.

At times it is also desired to be able to monitor signals on the IN line without interrupting the IN line signal. To accomplish this, a plug is inserted into the monitor in port 112b. When the plug is inserted into the port 112b, the plug taps into the in signal being transmitted through circuit path 408 between contacts XTI and TI, and circuit path 410 between contacts XRI and RI.

#### VI. Coaxial Rear Interface Assembly

Figure 19 illustrates a rear interface assembly 500 adapted to be secured to the jack mount 22. As shown in FIG. 20, the rear interface assembly 500 includes eight coaxial connectors 502. Four of the connectors 502 are IN connectors and four are OUT connectors. It will be appreciated that the rear interface assembly 500 and the rear interface assembly 64 are both compatible with or mountable on a common jack. Hence, the same jack can be used to manufacture jack assemblies suited for either twisted pair or coaxial type signals. By using common parts, manufacturing efficiency is enhanced.

Figures 21–23 illustrate one of the connectors 502. As shown in figure 23, the connector 502 is a type 1.6/5.6 connector and includes a grounded main body 512, a center conductor 514, and an insulator 517 mounted between the center conductor 514 and the main body 512. The main body includes a nut portion 516 having a generally hexagonal configuration. First and second threaded portions 518 and 520 are positioned on opposite sides of the nut portion 516. As best shown in figure 23, the main body also includes a pair of spaced-apart axial projections 522 that project axially from the main body 512. The first threaded portion 518 is positioned between the projections 522 and the nut portion 516, and the second threaded portion is adapted for connection to a coaxial connector. The axial projections 522 include notches 524 for facilitating terminating wires. The central conductor also projects outward the main body 512 at a location between the axial projections 522.

While a 1.6/5.6 type connector is shown, it will be appreciated that other types of coaxial connector could be used. For example, figures 24–26 show a BNC style connector 502' suitable for use with the rear interface assembly. The connector 502' includes a grounded main body 512', a center conductor 514', and a three-legged insulator 517' mounted between the center conductor 514' and the main body 512'. The main body includes a nut portion 516' having a generally hexagonal configuration, and a pair of spaced-apart axial projections 522' that project axially from the main body 512'. A threaded portion 518' is positioned axially between the nut portion 516' and the projections 522'. The axial projections include notches 524' for facilitating terminating wires. The central conductor 514' projects outward from the main body 512' at a location between the axial projections 522'.



Referring again to figure 19, the rear interface assembly 500 includes a dielectric support 506 having a front side 508 that faces the jack mount 22 and a back side 510 that faces away from the jack mount 22. A circuit board 507 is positioned between the support 506 and the jack mount 22. The coaxial connectors 502 project outward from the back side 510 to provide access for connections. As shown in figure 20, the nut portions 516 of the connectors 502 are mounted within hexagon-shaped recesses 509 defined by the support 506. The nut portions 516 seat upon shoulders (not shown) within the recesses 509.

The circuit board 507, the jack mount 22 and the dielectric support 506 define coaxially aligned openings sized to receive fasteners 569 (e.g., bolts or screws) for connecting the pieces together. The fasteners 569 are preferably press fit through captivation washers (not shown) that hold the pieces 22, 507 and 506 together after assembly. The fasteners 569 are also used to connect the pieces 22, 507 and 506 to the chassis 20 (shown in Figure 1).

A receptacle 513 for connection to one of the receptacles 54 of the power strip 52 also projects outward from the back side 510. The receptacle 513 is arranged to house a voltage lead 562, a return lead 561 and a sleeve ground lead 560. The leads 560-562 are electrically connected to the circuit board 507.

As shown in figure 19, the axial projections 522 and center conductors 514 extend through the dielectric support 506 and into chambers 546 formed in the front side 508 of the support 506. The front side 508 of the support 506 also defines a plurality of pockets 525 in which baluns 526 are retained or housed. One balun 526 corresponds to each connector 502. The front side 508 further includes a plurality of mounting bosses or pedestals 528 in which a plurality of connection pins 530 are press fit or staked. The pins 530 project outward from the front side 508 and are arranged in a predetermined array that corresponds to an array of contacts (e.g., plated through-holes) of the circuit board 507. To accommodate the arrangement of the pins 530, the circuit board 507 typically has a different contact and circuit pathway configuration than the circuit board 68 of the twisted pair rear interface assembly 64.

Referring now to figure 27, the dielectric support 506 includes a connector support piece 532 that is detachably connected to a balun housing piece 534. The balun housing piece 534 includes the generally rectangular pockets 525 for retaining the baluns 526, and the pedestals 528 for mounting the pins 530. The connectors 502 are secured to the connector support piece 532 by internally threaded lock rings 536 that are threaded on the first threaded portions 518 of the connectors 502. To support the connectors 502, the support piece 532 includes integrally formed cylindrical sleeves 538 defining through-holes 540 for receiving the

connectors 502. The cylindrical sleeves 538 also include rear seating surfaces 542 against which the lock rings 536 are tightened when the lock rings 536 are threaded on the first threaded portions 518 of the connectors. Interference between the lock rings 536 and the rear seating surfaces 542 prevent the connectors 502 from being  
5 pulled from the connector support piece 532. When the pieces 532 and 534 are connected, the rings 536 are concealed or housed within a chamber formed between the pieces 532 and 534.

The balun housing piece 534 defines the chambers 546 into which the extensions 522 and the central conductors 514 of the plugs 502 project when the  
10 assembly 500 is assembled. For example, at each chamber 546 the balun housing piece 534 defines two curved openings 550 (shown in figures 28–30) for receiving the extensions 522 of the connectors 502, and a circular opening 552 between the curved openings 550 for receiving the central conductors 514 of the plugs 502. The housing piece 534 also defines a plurality of covers 554 for covering one of each pair  
15 of extension members 522.

Referring still to figures 28–30, the conductive pins 530 are divided into eight pairs of tip and ring contacts with each pair of tip and ring contacts corresponding to one of the connectors 502. The pairs of pins 530 corresponding to the OUT connectors 502 have been labeled TO (tip out) and RO (ring out), while the  
20 pairs of pins 530 corresponding to the IN connectors 502 have been labeled TI (tip in) and RI (ring in). When a coaxial signal arrives through one of the OUT connectors 502, the balun 526 corresponding to the connector converts the unbalanced coaxial signals to balanced twisted pair signals (i.e., tip and ring signals). The tip signal is forwarded from the balun 526 to its corresponding TO pin and the  
25 ring signal is forwarded to its corresponding RO pin. From the RO and TO pins, the signals are directed to a corresponding jack mounted within the jack mount 22 via circuit pathways on the circuit board 507. The baluns 526 corresponding to the IN connectors 502 are adapted to convert balanced twisted pair signals into unbalanced coaxial signals. For example, when tip and ring signals from a cross-connected jack  
30 arrive at one of the baluns 526, the balun converts the tip and ring signals into a coaxial signal that is outputted through the balun's corresponding IN connector. It will be appreciated that the electrical pathways that connect the TO, RO, TI and RI pins to corresponding jacks mounted within the jack mount 22 can be schematically depicted in that same manner as the TO, RO, TI and RI contacts of figure 18. It will  
35 also be appreciated that the baluns 526 function to match the impedance between the unbalanced coaxial signals and the balanced twisted pair signals.

Still referring to figures 28–30, the baluns 526 preferably comprise torroid magnets each having two wound wires 570 and 572. The wires 570, 572

respectively terminate at ends 570a, 570b and 572a, 572b. To electrically connect one of the baluns 526, the ends 570a, 570b are respectively terminated at the central conductor 514 and one of the extensions 522 of the balun's corresponding connector 502, and the ends 572a, 572b are respectively terminated at the tip pin and the ring  
5 pin corresponding to the balun.

Having described preferred aspects and embodiments of the present invention, modifications and equivalents of the disclosed concepts may readily occur to one skilled in the art. However, it is intended that such modifications and equivalents be included within the scope of the claims which are appended hereto.

We claim:

1. A jack assembly comprising:

a jack mount having a front side and a rear side, the jack mount also including top and bottom supports defining a jack receiving region that opens  
5 outward toward the front side of the jack mount;

a jack adapted to be slidably mounted in the jack receiving region defined between the top and bottom supports of the jack mount, the jack including a jack body formed of a dielectric material, the jack body defining a plurality of bores sized to receive plugs having tip and ring contacts;

10 the jack including a plurality of electrically conductive tip and ring springs, the tip springs being adapted to make electrical contact with the tip contacts of the plugs when the plugs are inserted within the bores, and the ring springs being adapted to make electrical contact with the ring contacts of the plugs when the plugs are inserted within the bores;

15 the jack including a plurality of normal contacts adapted to normally make electrical contact with the tip and ring springs;

a plurality of cross-connect contacts;

a rear interface assembly including a dielectric support having a first side that faces the jack mount and a second side that faces away from the jack  
20 mount, the rear interface assembly also including a plurality of rear connectors that project outward from the second side of the dielectric support;

the rear interface assembly further including a circuit board positioned between the jack mount and the dielectric support, the circuit board being configured to provide electrical connections between the rear connectors and the tip and ring springs, the circuit board also being configured to provide electrical  
25 connections between the cross-connect contacts and the normal contacts;

a resilient retaining member connected to one of the jack and the jack mount for securing the jack within the jack mount, the resilient retaining member being moveable between a first position in which the retaining member is adapted to  
30 retain the jack within the jack mount, and a second position in which the jack can be inserted into or removed from the jack mount; and

an electrical interface between the jack and the circuit board, the electrical interface being configured such that when the jack is removed from the jack mount, the jack is electrically disconnected from the circuit board.

35 2. The jack assembly of claim 1, wherein the rear connectors of the rear interface assembly comprise wire wrap members.

3. The jack assembly of claim 1, wherein the rear connectors of the rear interface assembly comprise coaxial connectors, and the rear interface assembly further includes baluns electrically connected to the coaxial connectors.
- 5 4. The jack assembly of claim 1, wherein the jack includes a first LED having first and second electrical leads, wherein the cross-connect contacts include a tracer lamp contact, and wherein the first lead is electrically connected to a power source and the second lead is electrically connected to the tracer lamp contact.
- 10 5. The jack assembly of claim 4, wherein one of the bores comprises a monitor bore and the jack further includes a return spring positioned between the monitor bore and the first LED, the return spring being positioned such that when a plug is inserted into the monitor bore, the return spring is pressed against the second lead of the first LED causing the first LED and a second LED of a second jack  
15 corresponding to the tracer lamp to be illuminated.
6. The jack assembly of claim 1, wherein the jack includes a front face positioned opposite from a rear face, the bores of the jack being defined by the front face, the jack including contact members that project outward from the rear face, the  
20 contact members being configured to form a portion of the electrical interface between the jack and the circuit board, and the contact members being electrically connected to the normal contacts, the tip springs and the ring springs.
7. The jack assembly of claim 6, wherein at least some of the contact members  
25 project outward a first distance from the rear face of the jack and others of the contact members project outward a second distance from the rear face of the jack, the first distance being greater than the second distance.
8. The jack assembly of claim 6, wherein the contact members are received  
30 within corresponding holes defined by the jack mount.
9. The jack assembly of claim 8, further comprising jack mount connectors mounted within the holes for providing electrical connections between the contact members and the circuit board.
- 35 10. The jack assembly of claim 9, wherein each jack mount connector includes opposing first and second portions between which a corresponding one of the contact members is received.

11. The jack assembly of claim 10, wherein the jack mount connectors are press-fit within the holes of the jack mount and include pins for providing the electrical connections with the circuit board.
- 5 12. The jack assembly of claim 3, wherein the baluns of the rear interface assembly are mounted on the dielectric support and are electrically connected to rear interface contact members that project outward from the first side of the support, the rear interface contact members being adapted to provide electrical connections between the baluns and the circuit board.
- 10 13. The jack assembly of claim 12, wherein the baluns are mounted within pockets defined by the dielectric support.
14. The jack assembly of claim 12, wherein the rear interface contact members  
15 comprise pins press fit within holes defined by bosses of the dielectric support.
15. The jack assembly of claim 12, wherein the dielectric support includes a first piece removeably connected to a second piece, the baluns being mounted on the first piece and the coaxial connectors being connected to the second piece.
- 20 16. The jack assembly of claim 15, wherein the coaxial connectors have threaded inner ends that extend through the second piece of the dielectric support, and the coaxial connectors are fastened to the second piece of the support by internally threaded members threaded on the threaded inner ends and positioned between the  
25 first and second pieces of the dielectric support.
17. The jack assembly of claim 15, wherein each coaxial connector includes a central pin and at least one ground extension that project through openings defined by the first piece of the support.
- 30 18. The jack assembly of claim 17, wherein each coaxial connector includes two ground extensions positioned on opposite sides of the central pin.
19. The jack assembly of claim 12, wherein the coaxial connectors have threaded  
35 inner ends that extend through the dielectric support, and the coaxial connectors are fastened to the dielectric support by internally threaded members threaded on the threaded inner ends.

20. The jack assembly of claim 1, wherein the cross-connect contacts are formed by wire wrap pins.
21. The jack assembly of claim 1, wherein the jack mount includes a first portion  
5 for mounting the jack, and a second portion for mounting the cross-connect contacts, the first and second portions being connected at a mechanical interface arranged and configured for allowing the second portion to be disconnected from the first portion.
22. The jack assembly of claim 21, wherein the mechanical interface includes a  
10 tongue and groove configuration.
23. The jack assembly of claim 1, further comprising a chassis in which the jack mount is mounted, the chassis including a top wall positioned opposite from a  
15 bottom wall, the top wall including a removable front portion for providing access to the jack mount.
24. The jack assembly of claim 1, wherein the jack is one of a plurality of jacks mountable within the jack mount, each of the jacks including a separate resilient  
20 retaining member for individually retaining each jack within the jack mount.
25. The jack assembly of claim 24, wherein the plurality of jacks includes odd jack and even jacks having different configurations, and the jack mount defines first  
25 mounting locations configured to exclusively receive the odd jacks and second mounting locations configured to exclusively receive the even jacks.
26. The jack assembly of claim 25, wherein the first mounting locations of the jack mount include top and bottom channels configured to receive and complement  
30 top and bottom portions of the odd jacks, and the second mounting locations define top and bottom channels configured to receive and complement top and bottom portions of the even jacks.
27. A jack assembly comprising:  
a jack mount having a front side and a rear side;  
a jack positioned at the front side of the jack mount, the jack  
35 including a jack body formed of a dielectric material, the jack body defining a plurality of bores each sized to receive a plug having a tip contact and a ring contact;  
the jack including a plurality of electrically conductive tip and ring springs, the tip springs being adapted to make electrical contact with the tip contacts

of the plugs when the plugs are inserted within the bores, and the ring springs being adapted to make electrical contact with the ring contacts of the plugs when the plugs are inserted within the bores;

- the jack including a plurality of normal contacts adapted to normally  
5 make electrical contact with the tip and ring springs;  
a plurality of cross-connect contacts; and  
a rear interface assembly positioned at the rear side of the jack mount,  
the rear interface assembly including a dielectric support having a first side that  
faces the jack mount and a second side that faces away from the jack mount, the rear  
10 interface assembly also including a plurality of baluns supported by the dielectric  
support, the rear interface assembly further including a plurality of coaxial  
connectors that project outward from the second side of the support and are  
electrically connected to the baluns, the rear interface assembly further including  
contact members that project outward from the first side of the support and are  
15 electrically connected to the baluns, and a circuit board in electrical contact with the  
contact members of the rear interface assembly, the circuit board providing electrical  
connections between the contact members and the tip and ring springs, the circuit  
board also providing electrical connections between the cross-connect contacts and  
the normal contacts.

20

28. The jack assembly of claim 27, wherein the baluns are mounted within  
pockets defined by the dielectric support.

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29. The jack assembly of claim 27, wherein the contact members comprise pins  
press fit within holes defined by the dielectric support.

30

30. The jack assembly of claim 27, wherein the dielectric support includes a first  
piece removeably connected to a second piece, the baluns being mounted on the first  
piece and the coaxial connectors being connected to the second piece.

35

31. The jack assembly of claim 30, wherein the coaxial connectors have threaded  
inner ends that extend through the second piece of the dielectric support, and the  
coaxial connectors are fastened to the second piece of the support by internally  
threaded members threaded on the threaded inner ends and positioned between the  
first and second pieces of the dielectric support.



32. The jack assembly of claim 30, wherein each coaxial connector includes a central pin and at least one ground extension that project through openings defined by the first piece of the dielectric support.
- 5 33. The jack assembly of claim 32, wherein each coaxial connector includes two ground extensions positioned on opposite sides of the central pin.
34. The jack assembly of claim 27, wherein the coaxial connectors have threaded inner ends that extend through the dielectric support, and the coaxial connectors are  
10 fastened to the dielectric support by internally threaded members threaded on the threaded inner ends.
35. A jack assembly comprising:
- 15 a jack mount having a front side and a rear side;  
a jack positioned at the front side of the jack mount, the jack including a jack body formed of a dielectric material, the jack body defining a plurality of bores each sized to receive a plug having a tip contact and a ring contact;  
the jack including a plurality of electrically conductive tip and ring springs, the tip springs being adapted to make electrical contact with the tip contacts  
20 of the plugs when the plugs are inserted within the bores, and the ring springs being adapted to make electrical contact with the ring contacts of the plugs when the plugs are inserted within the bores;
- the jack including a plurality of normal contacts adapted to normally make electrical contact with the tip and ring springs;
- 25 a plurality of cross-connect contacts electrically connected to the normal contacts;
- first and second rear interface assemblies that can be selectively secured to the rear side of the jack mount;
- the first rear interface assembly including a plurality of wire  
30 termination members, the wire termination members being electrically connected to the tip and ring springs when the first rear interface assembly is secured to the jack mount; and
- the second rear interface assembly including a plurality of coaxial connectors, each coaxial connector being electrically connected to a balun, and the  
35 baluns being electrically connected to the tip and ring springs when the second rear interface assembly is secured to the jack mount.

36. The jack assembly of claim 35, wherein the first rear interface assembly includes a circuit board including circuitry for electrically connecting the cross-connect contacts with the normal contacts, and for electrically connecting the wire termination members with the tip and ring springs.

5

37. The jack assembly of claim 35, wherein the second rear interface assembly includes a circuit board including circuitry for electrically connecting the cross-connect contacts with the normal contacts, and for electrically connecting the baluns with the tip and ring springs.

10

38. The jack assembly of claim 35, wherein the first rear interface assembly includes a first circuit board and the second rear interface assembly includes a second circuit board that is different from the first circuit board.

15

39. A jack comprising:

a jack body formed of a dielectric material, the jack body defining a plurality of bores sized to receive plugs having tip and ring contacts;

a plurality of electrically conductive tip and ring springs mounted at the jack body, the tip springs being adapted to make electrical contact with the tip contacts of the plugs when the plugs are inserted within the bores, and the ring springs being adapted to make electrical contact with the ring contacts of the plugs when the plugs are inserted within the bores;

a plurality of normal contacts adapted to normally make electrical contact with the tip and ring springs;

the jack body including a front face positioned opposite from a rear face, the bores of the jack being defined by the front face;

a plurality of contact members that project outward from the rear face, the contact members being electrically connected to the normal contacts, the tip springs and the ring springs; and

at least some of the contact members projecting outward a first distance from the rear face of the jack and others of the contact members projecting outward a second distance from the rear face of the jack, the first distance being greater than the second distance.

35

40. A jack mount comprising:

a jack mount body having a front side and a rear side, the jack mount body defining a jack receiving region that opens outward toward the front side of the jack mount body;

the jack mount body including a rear wall positioned at the rear side of the jack mount body, the rear wall defining a plurality of through-holes; and  
a plurality of electrical connectors mounted within the through-holes, each electrical connector including opposing first and second cantilever members  
5 that are press-fit within a corresponding one of the through-holes and a connector pin connected to the cantilever members, the connector pins being sized to project outward from the rear side of the jack mount body.

41. A method for mounting electrical connectors in a jack mount, the method  
10 comprising:

providing a plurality of the electrical connectors arranged in a row and connected to an insertion tool;  
using the insertion tool to concurrently insert the row of electrical connectors into a row of through-holes defined by the jack mount; and  
15 disconnecting the electrical connectors from the insertion tool.

42. The method of claim 41, wherein the electrical connectors are press-fit within the through-holes.

20 43. A jack mount comprising:

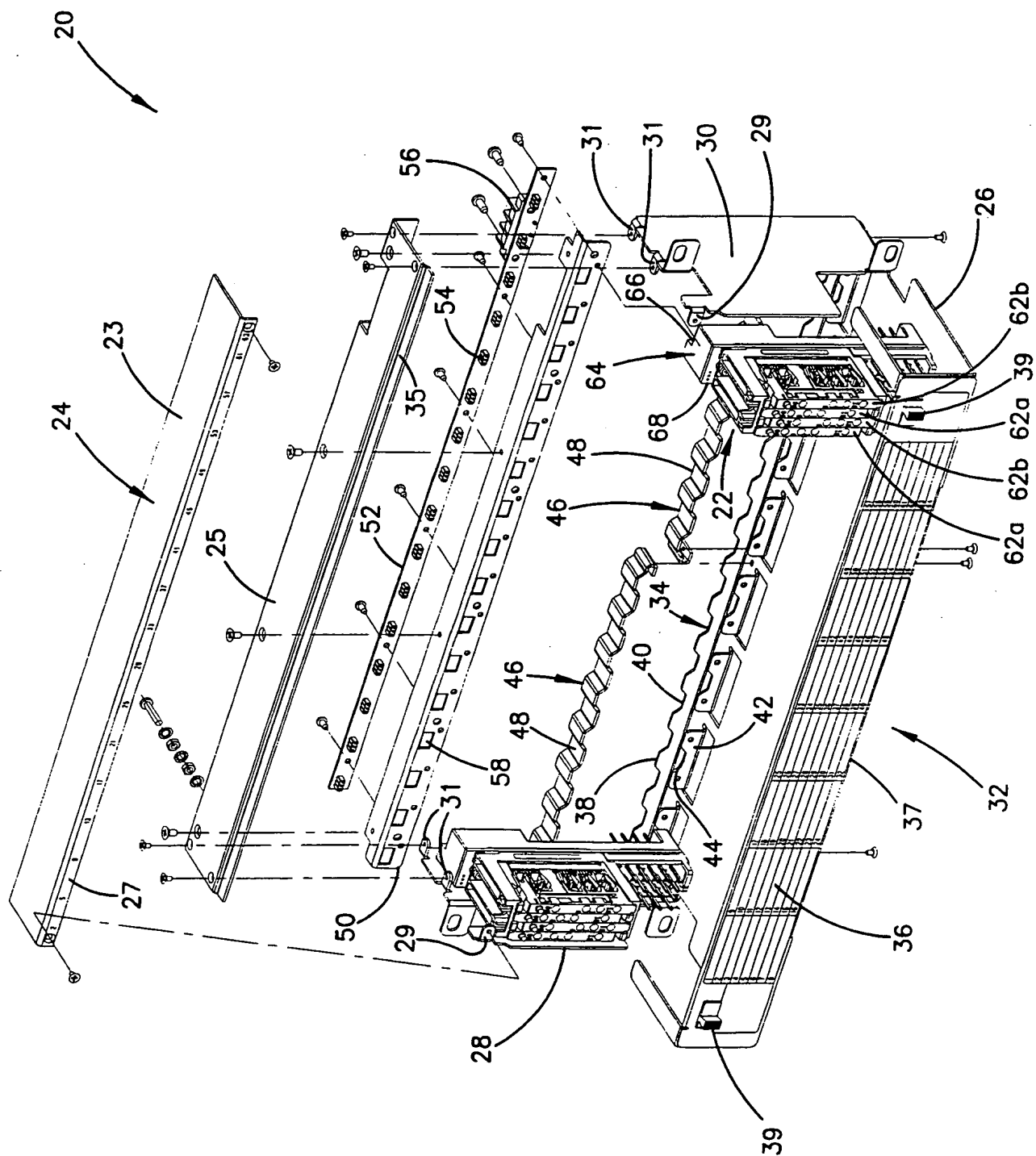
a jack mount body having a front side and a rear side, the jack mount body including a jack receiving portion that opens outward toward the front side of the jack mount body; and  
a cross-connector mounting body at which there are mounted a  
25 plurality of cross-connect contacts, the cross-connector mounting body and the jack mount body being connected at a mechanical interface arranged and configured for allowing the cross-connector mounting body to be disconnected from the jack mount body.

30 44. The jack assembly of claim 43, wherein the mechanical interface includes a tongue and groove configuration.

45. A jack mount assembly comprising:

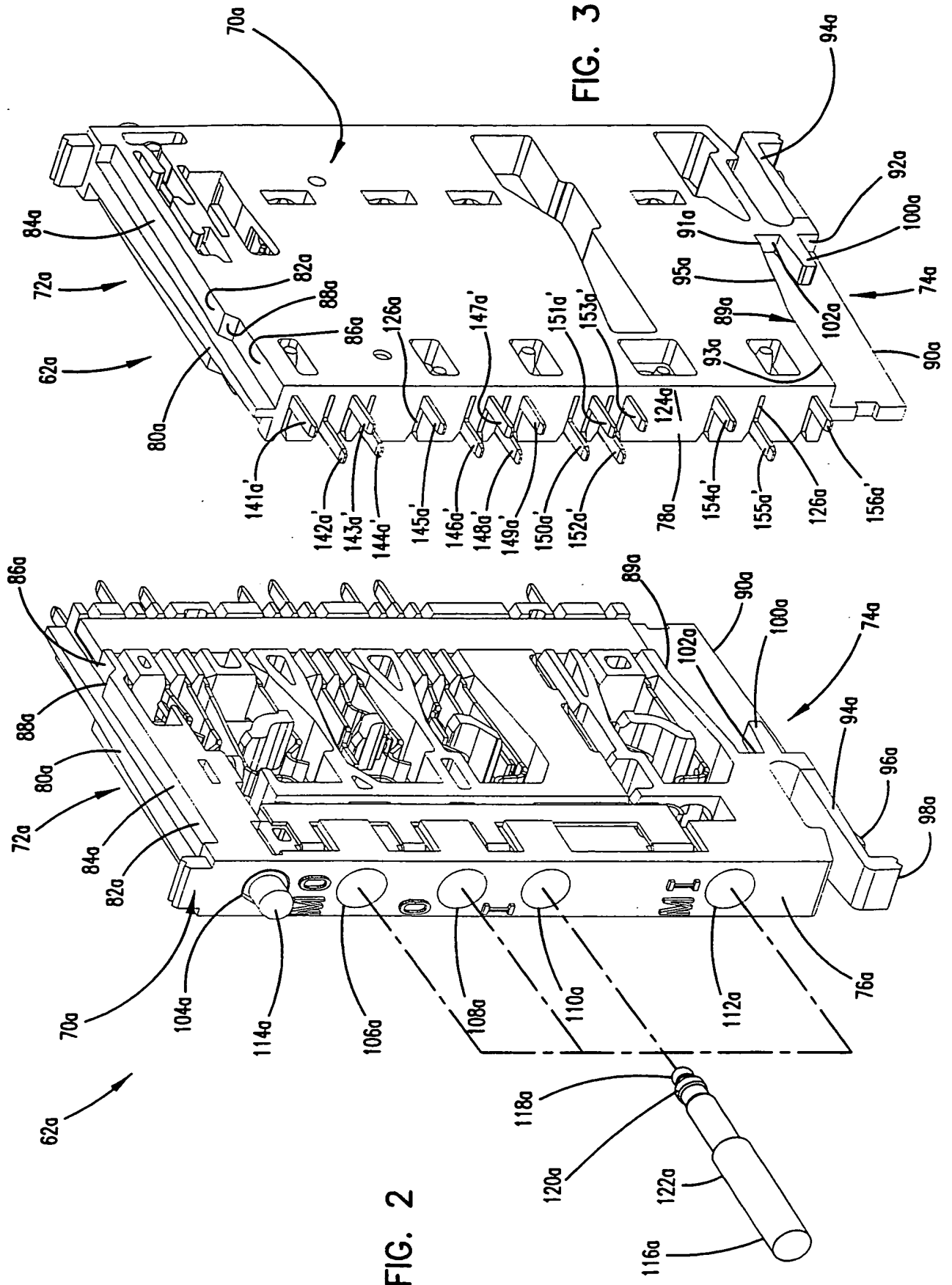
a jack mount having a front side and a rear side; and  
35 a rear interface assembly positioned at the rear side of the jack mount, the rear interface assembly including a dielectric support having a first side that faces the jack mount and a second side that faces away from the jack mount, the rear interface assembly also including a plurality of baluns supported by the dielectric

support, the rear interface assembly further including a plurality of coaxial connectors that project outward from the second side of the support and are electrically connected to the baluns, the rear interface assembly further including contact members that project outward from the first side of the support and are  
5 electrically connected to the baluns, and a circuit board in electrical contact with the contact members of the rear interface assembly, the circuit board providing electrical connections between the contact members and electrical contact members mounted at the jack mount.



**FIG. 1**

**SUBSTITUTE SHEET (RULE 26)**



SUBSTITUTE SHEET (RULE 26)

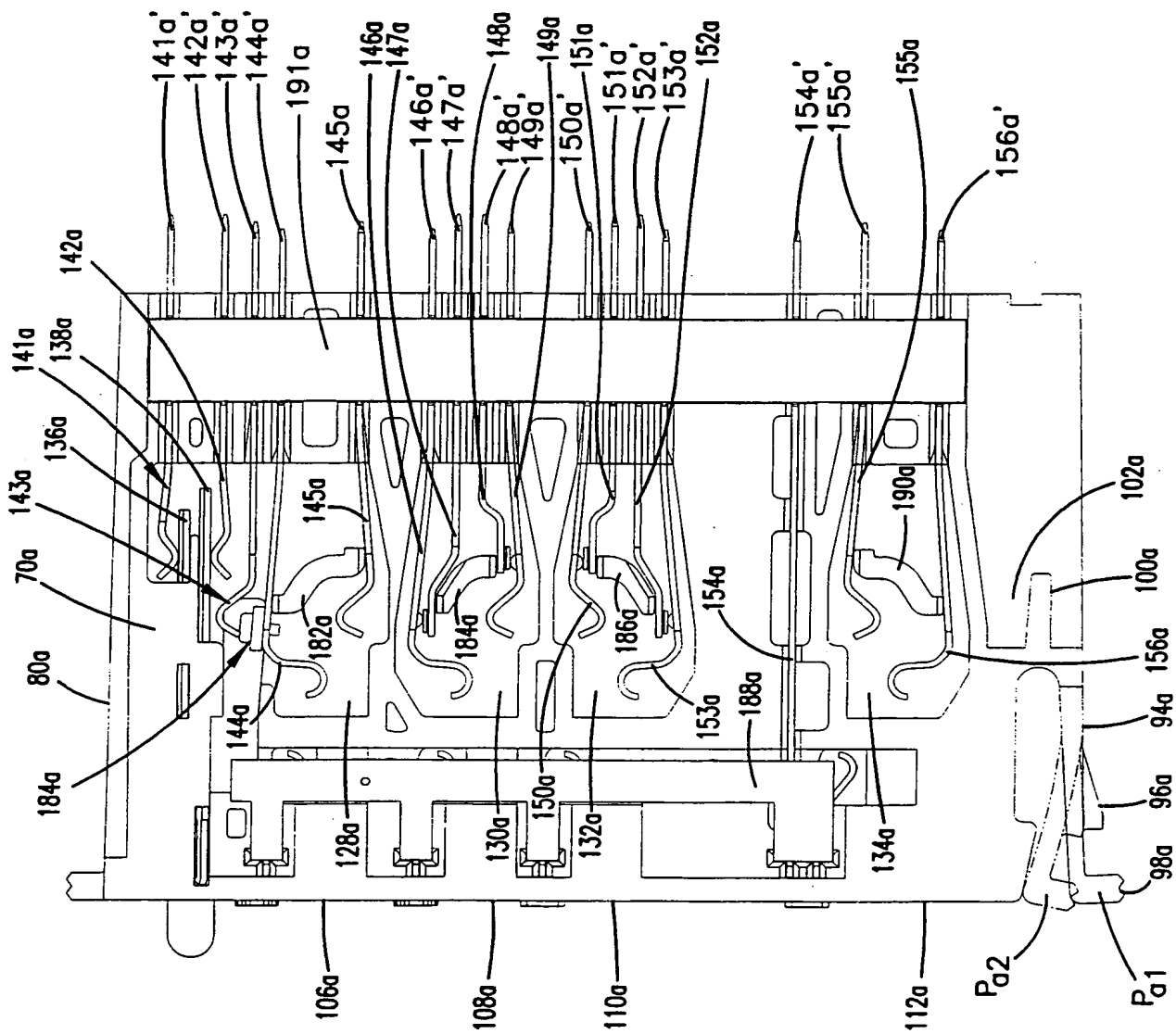
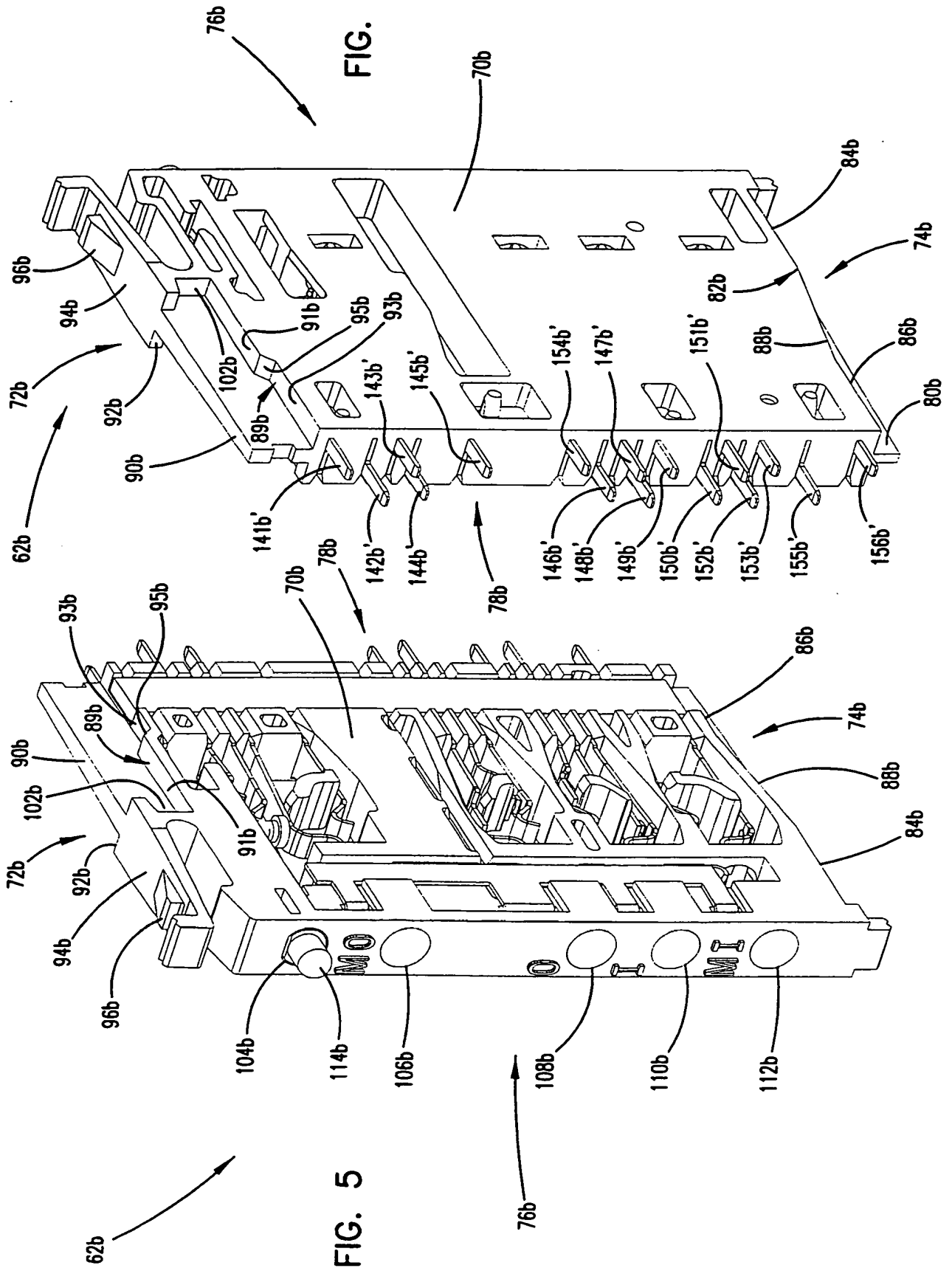
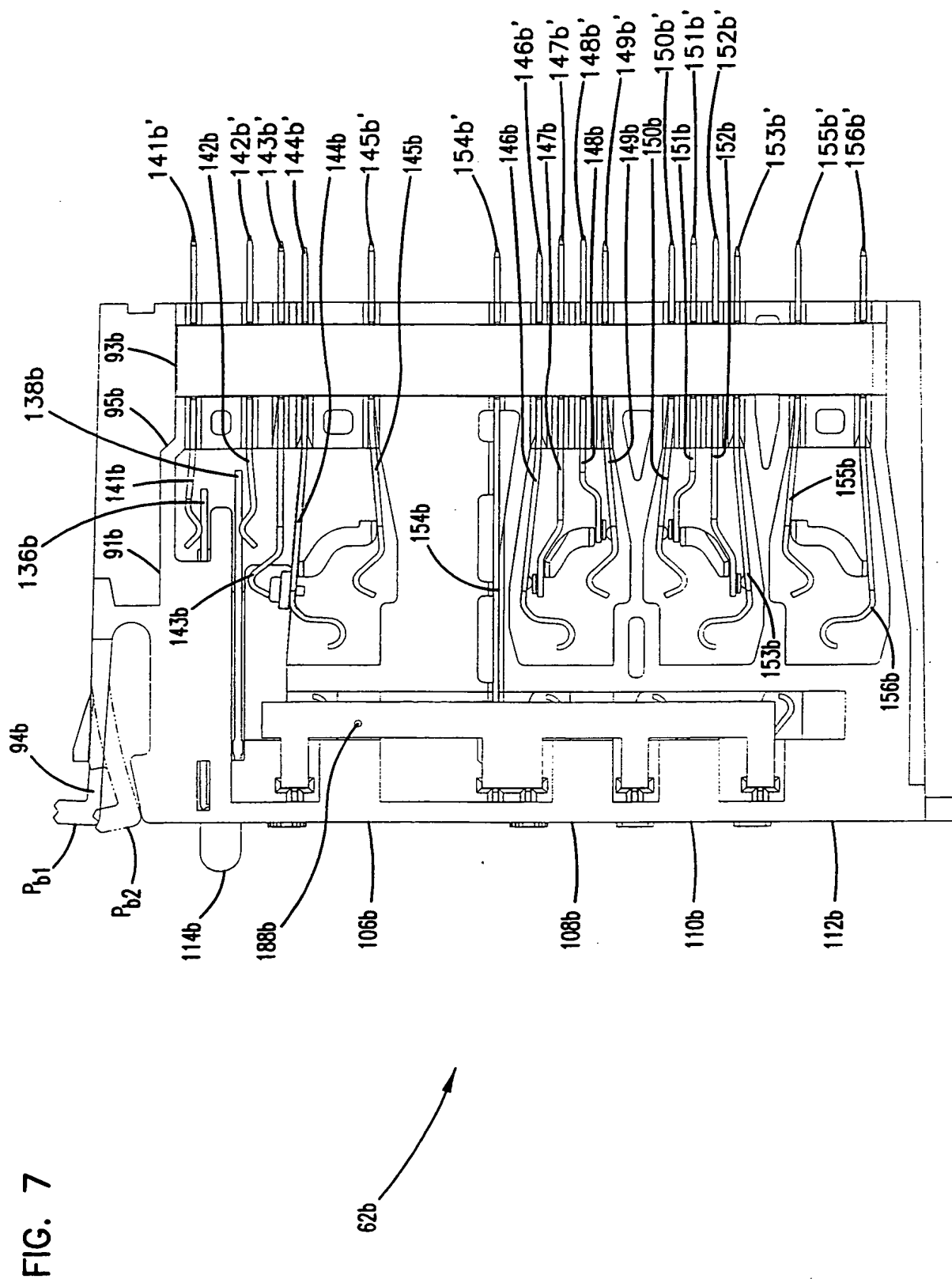


FIG. 4

SUBSTITUTE SHEET (RULE 26)







**SUBSTITUTE SHEET (RULE 26)**

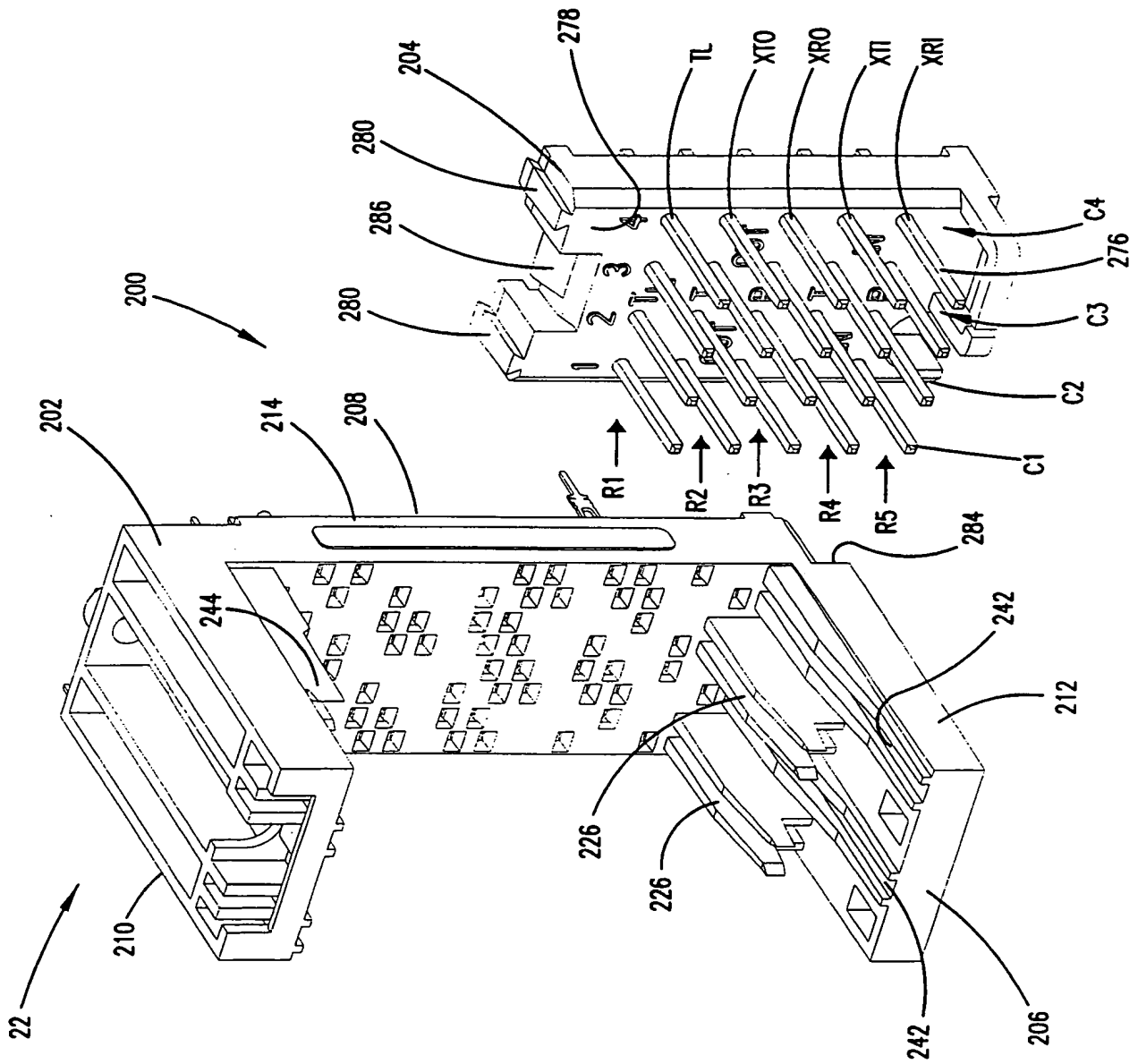
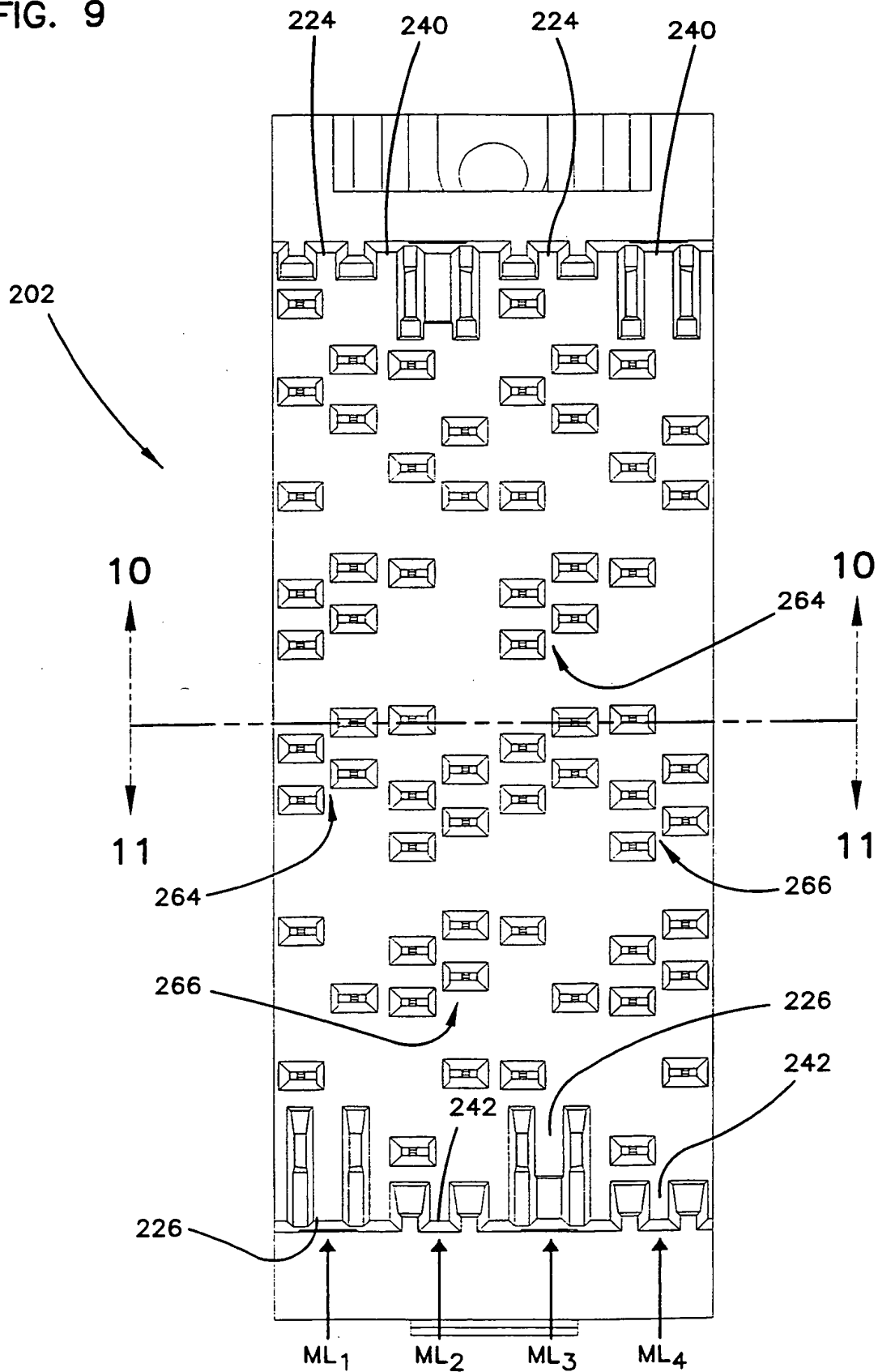


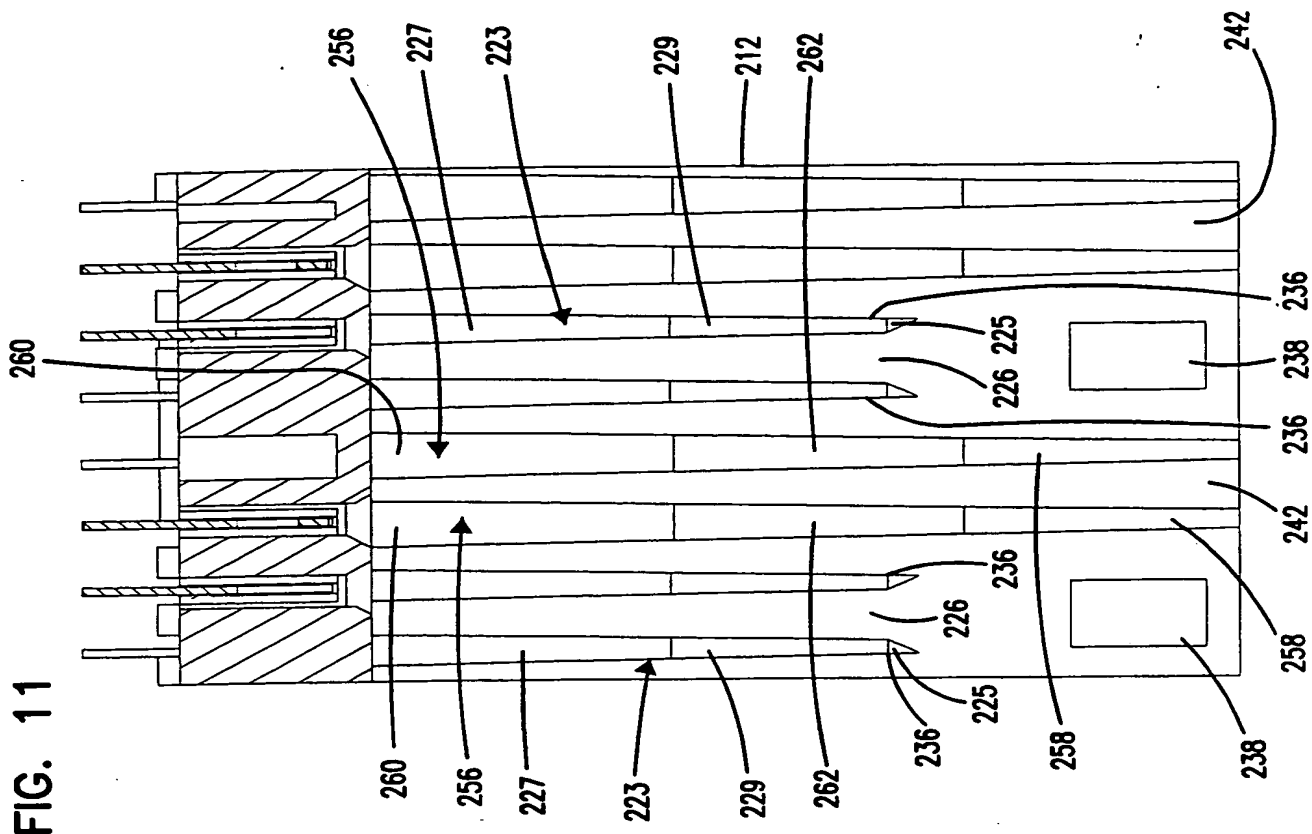
FIG. 8

**SUBSTITUTE SHEET (RULE 26)**

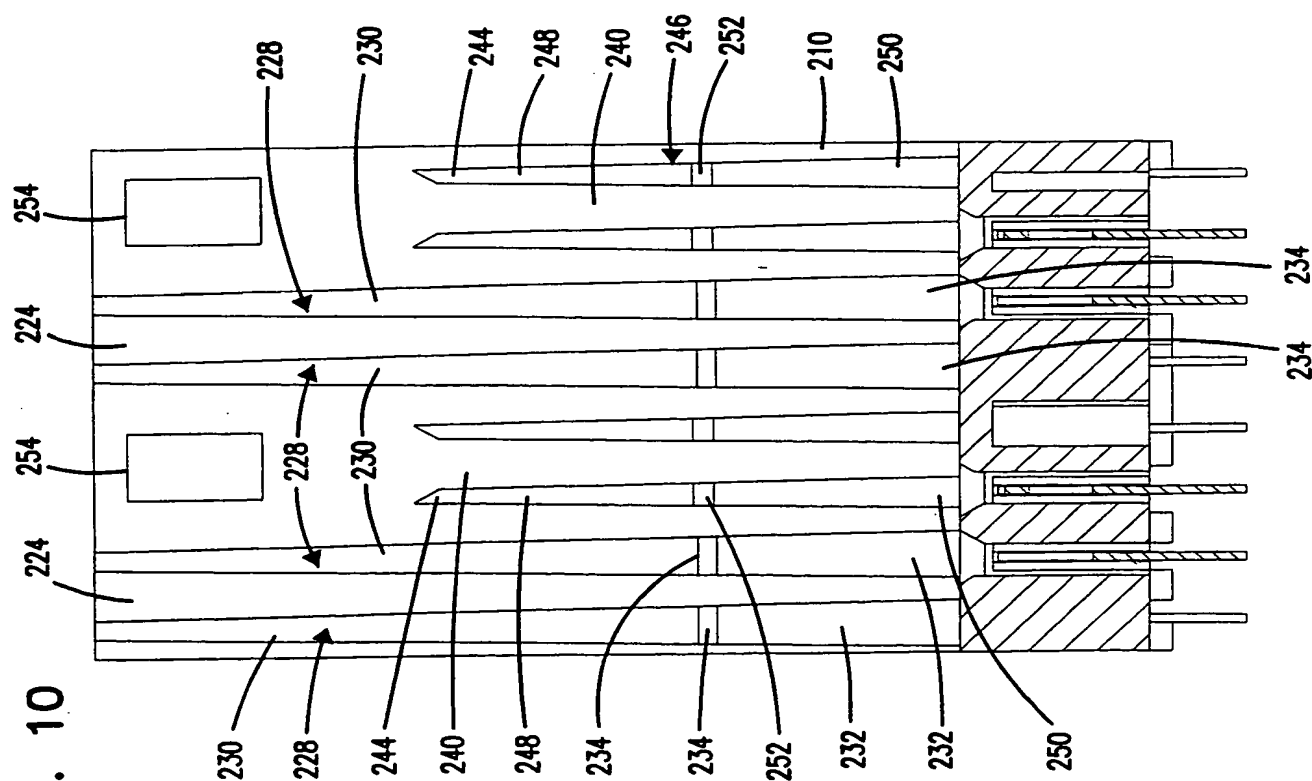
FIG. 9



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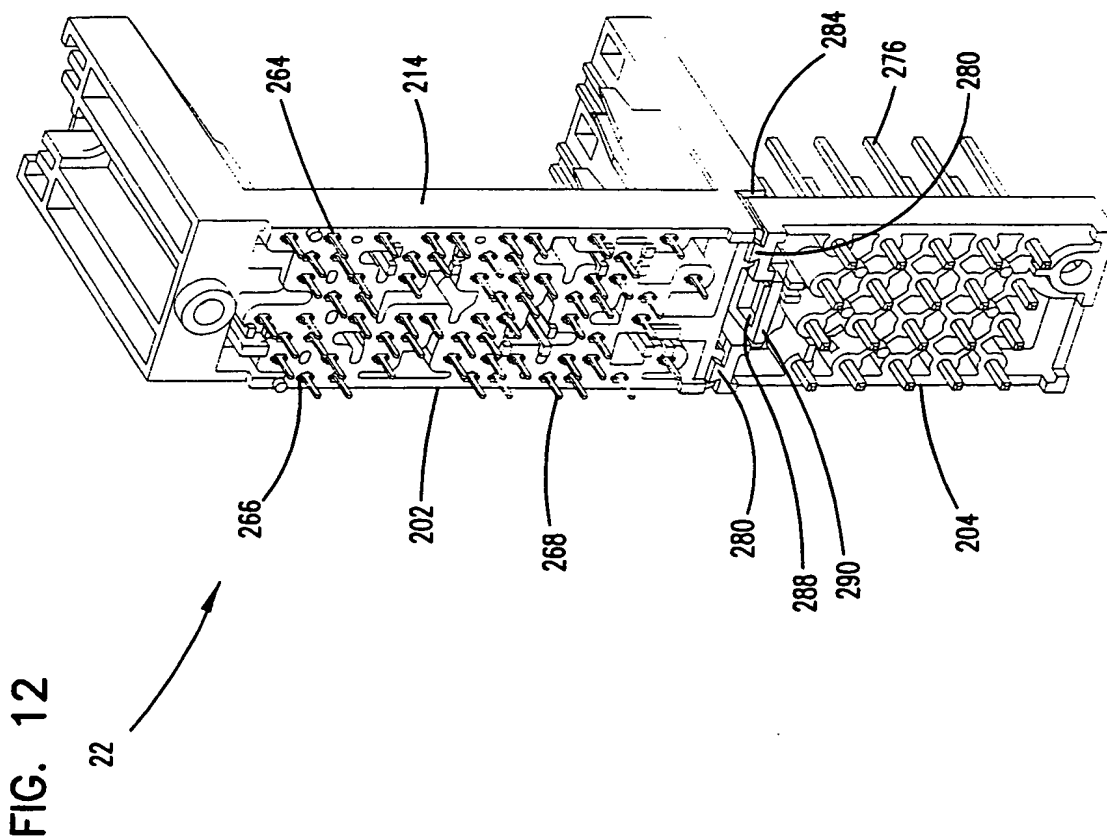
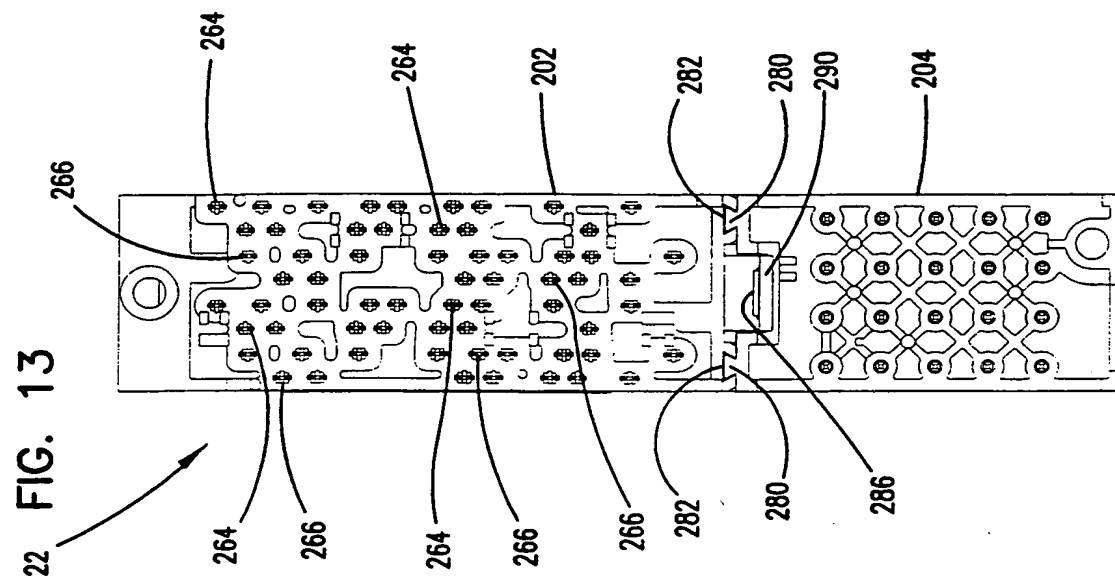


**FIG. 11**



**FIG. 10**

**SUBSTITUTE SHEET (RULE 26)**



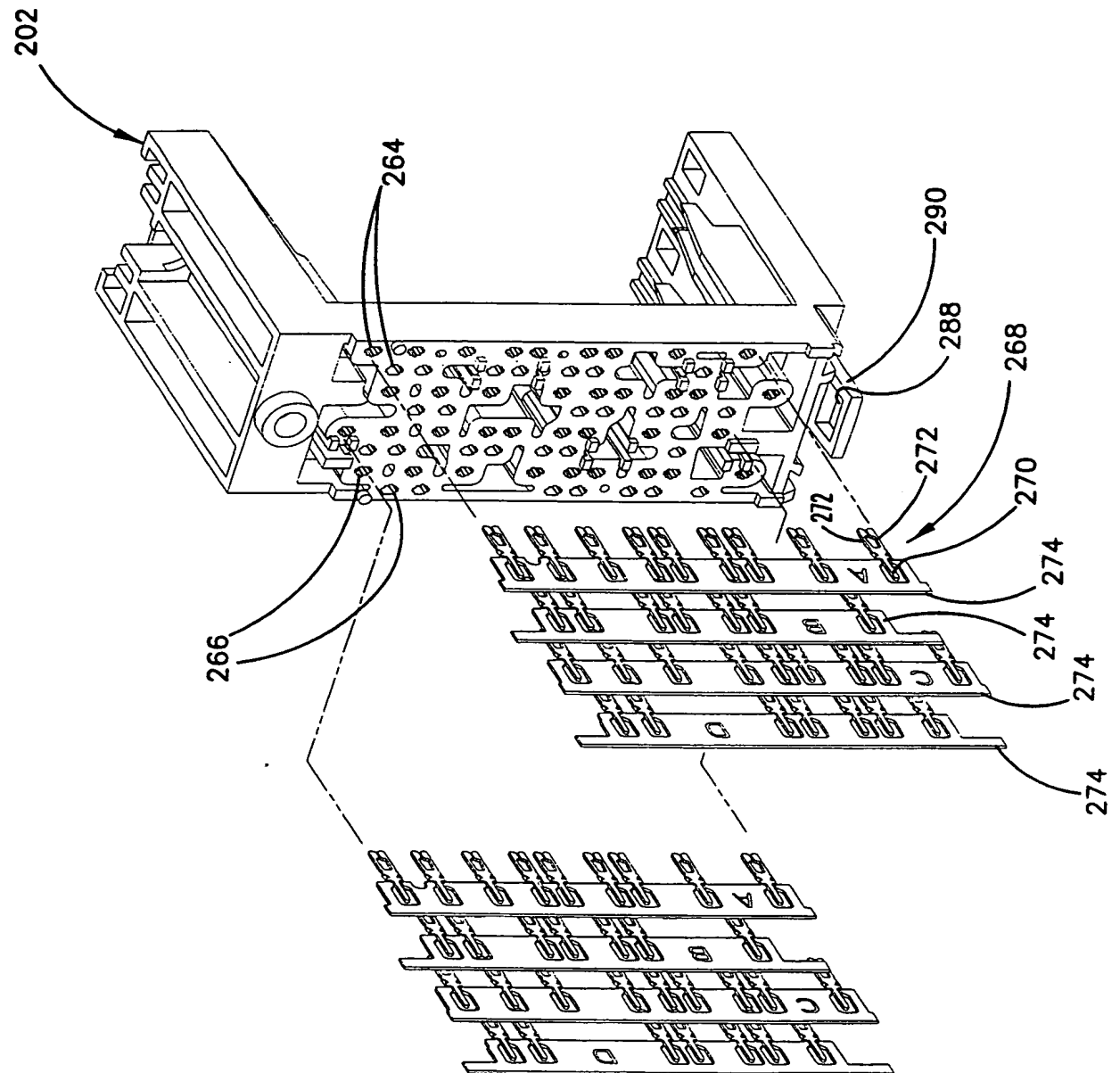
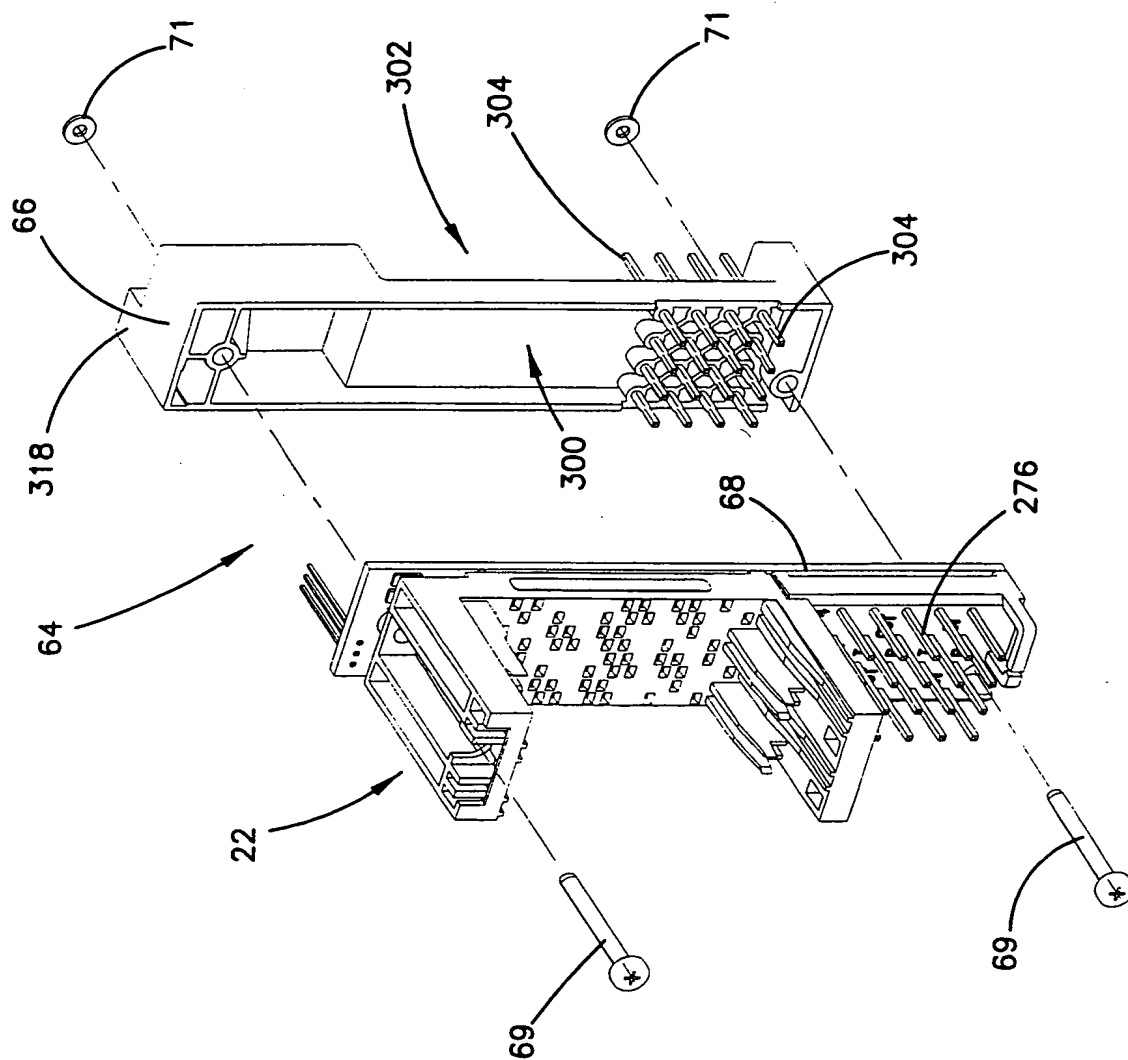
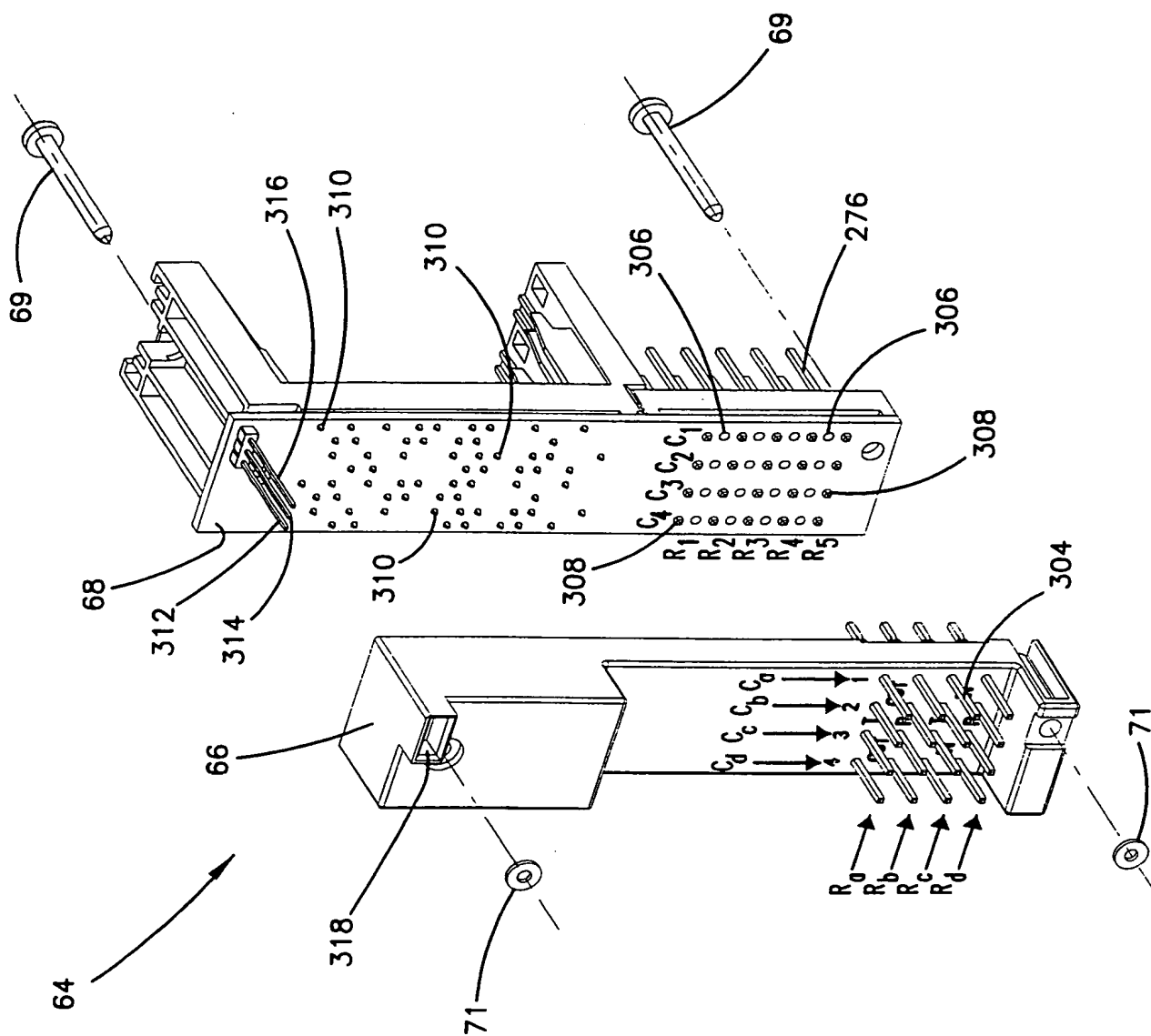


FIG. 14

FIG. 15



SUBSTITUTE SHEET (RULE 26)



**FIG. 16**

**SUBSTITUTE SHEET (RULE 26)**



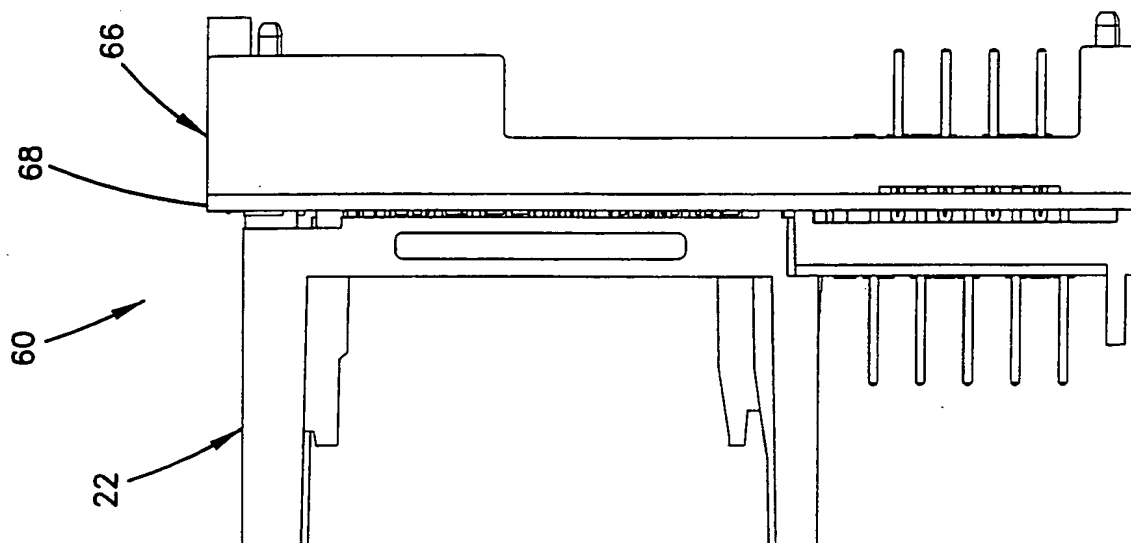
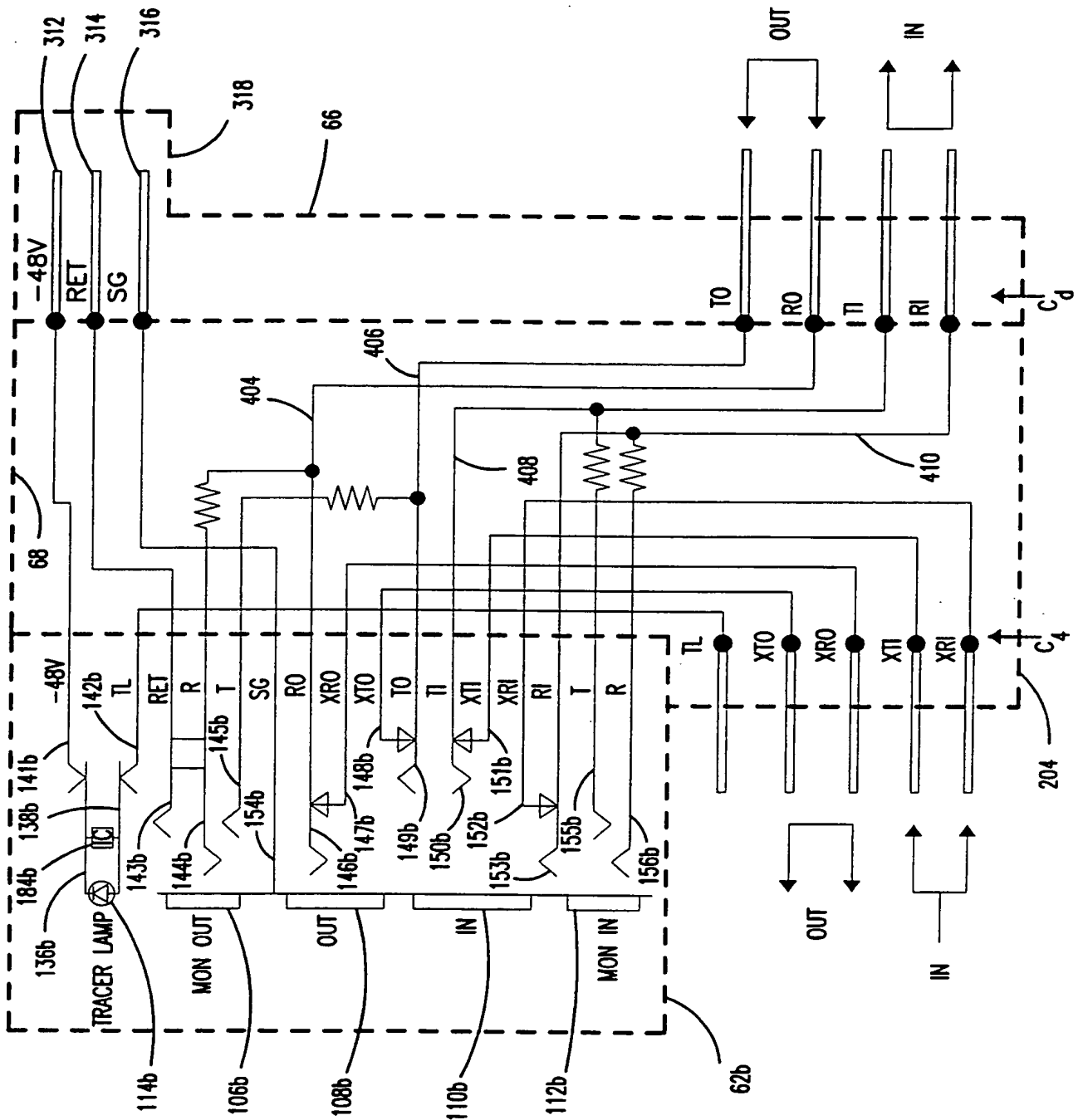


FIG. 17

**FIG. 18**



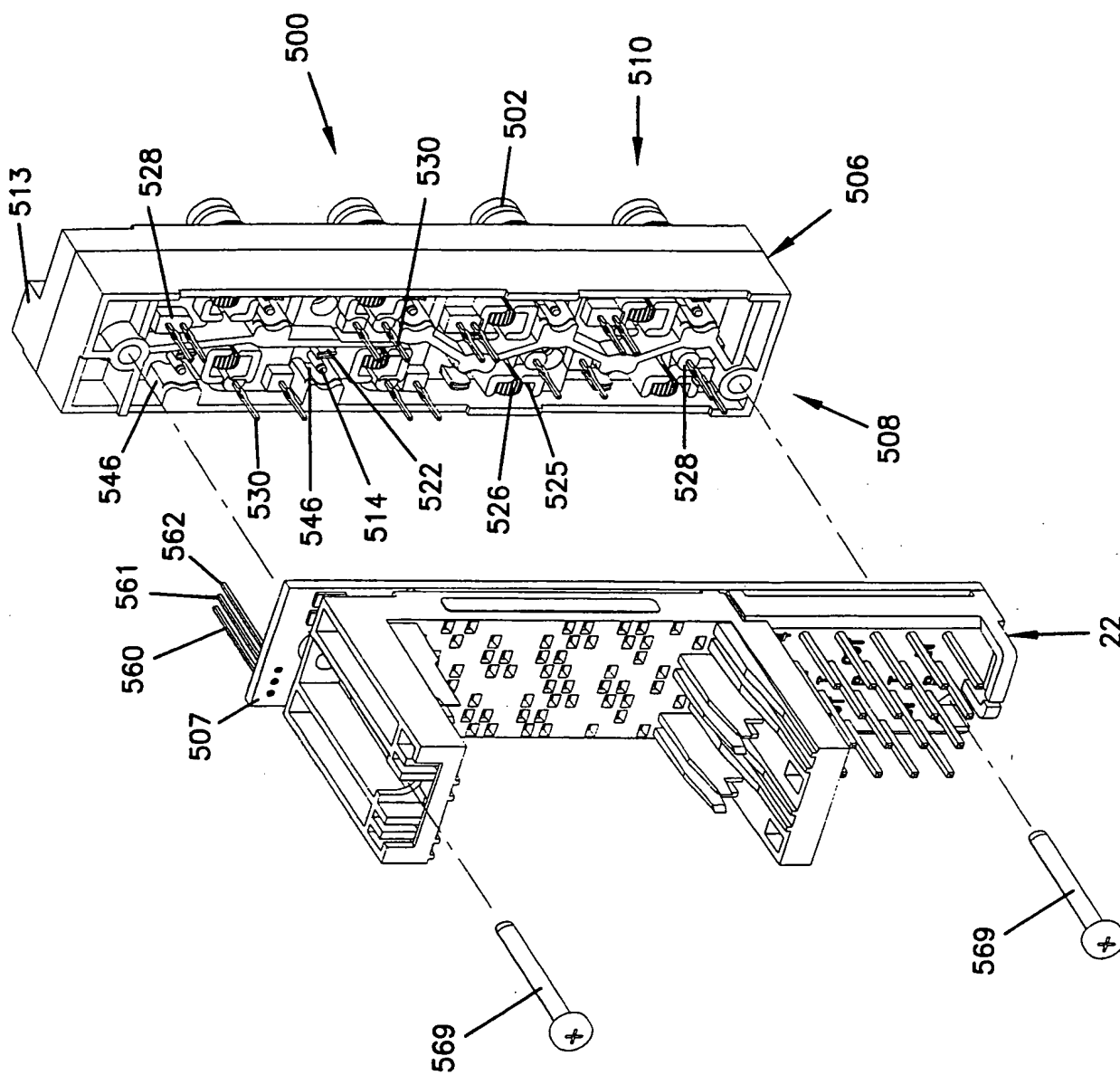


FIG. 19

FIG. 20

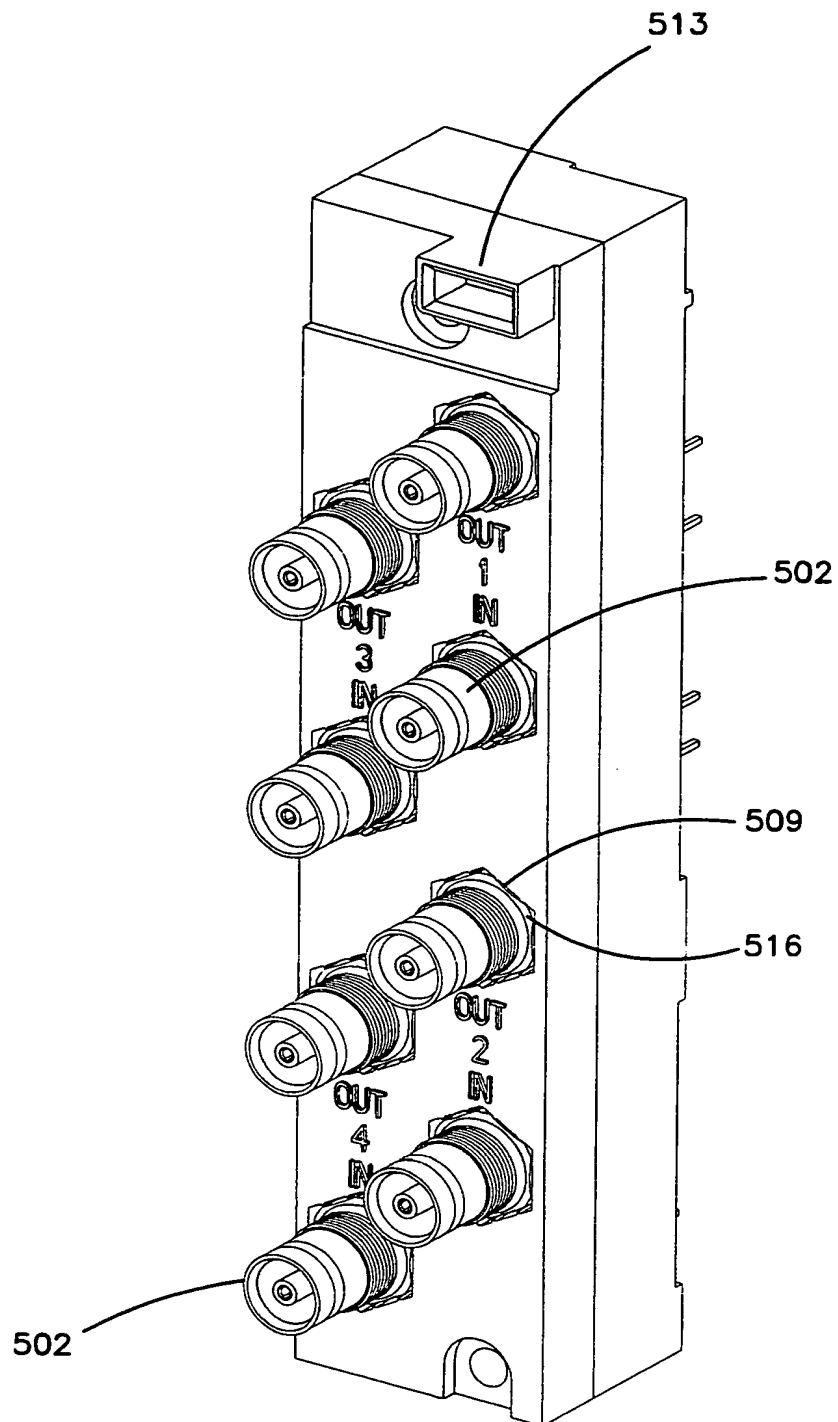


FIG. 21

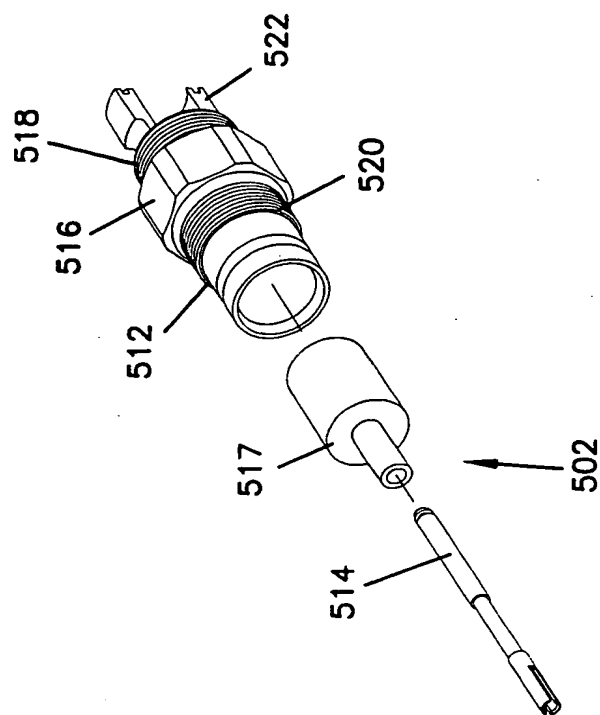


FIG. 22

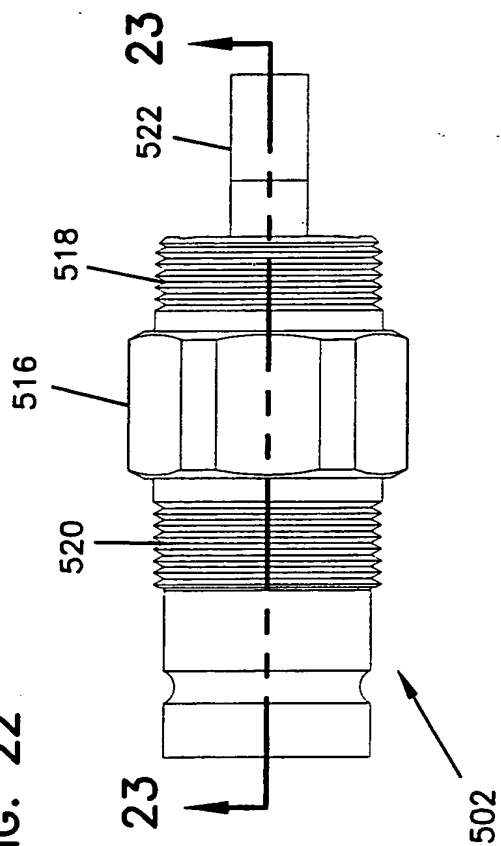


FIG. 23

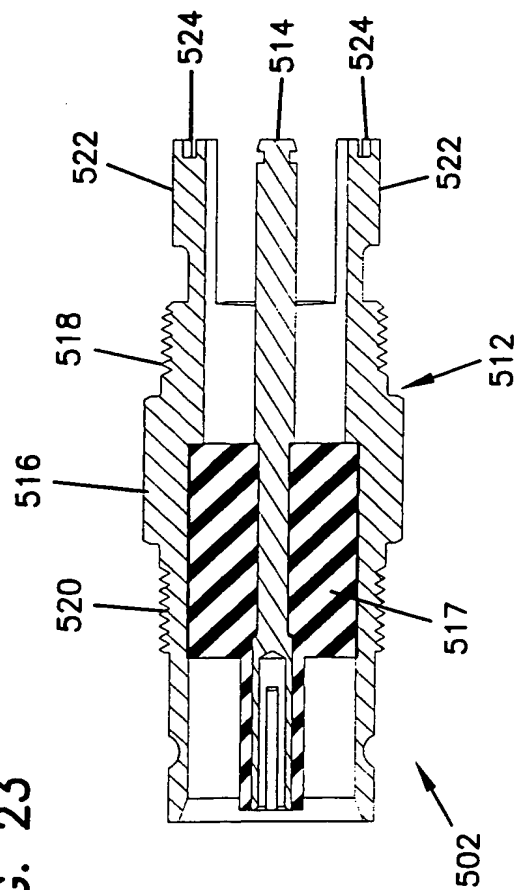


FIG. 24

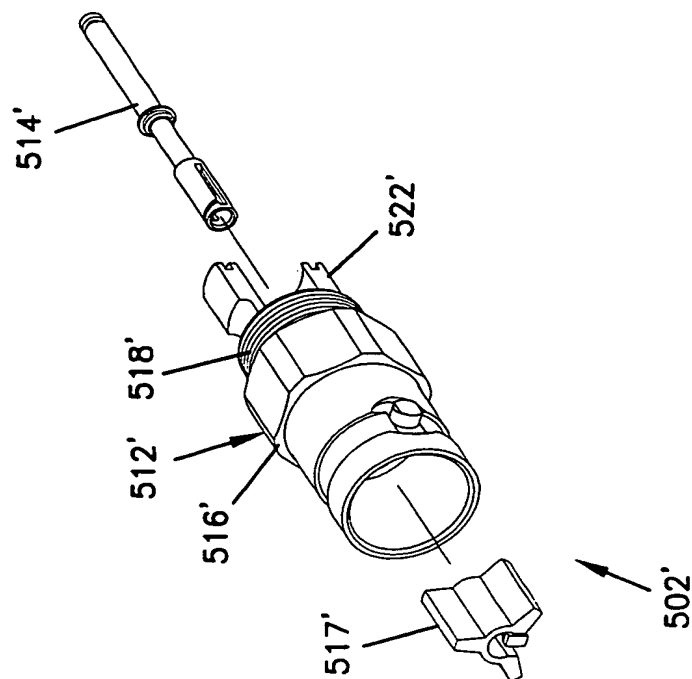


FIG. 25

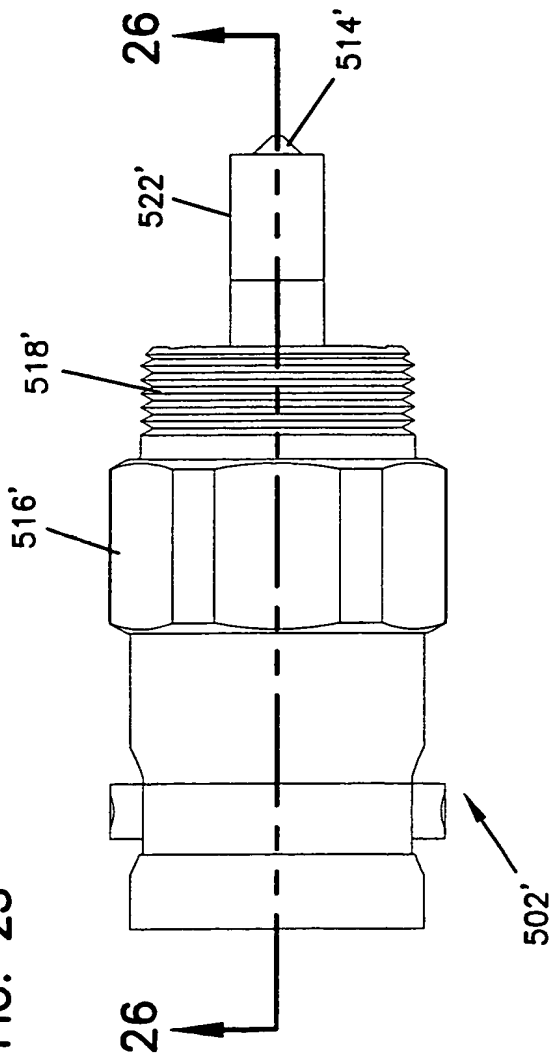
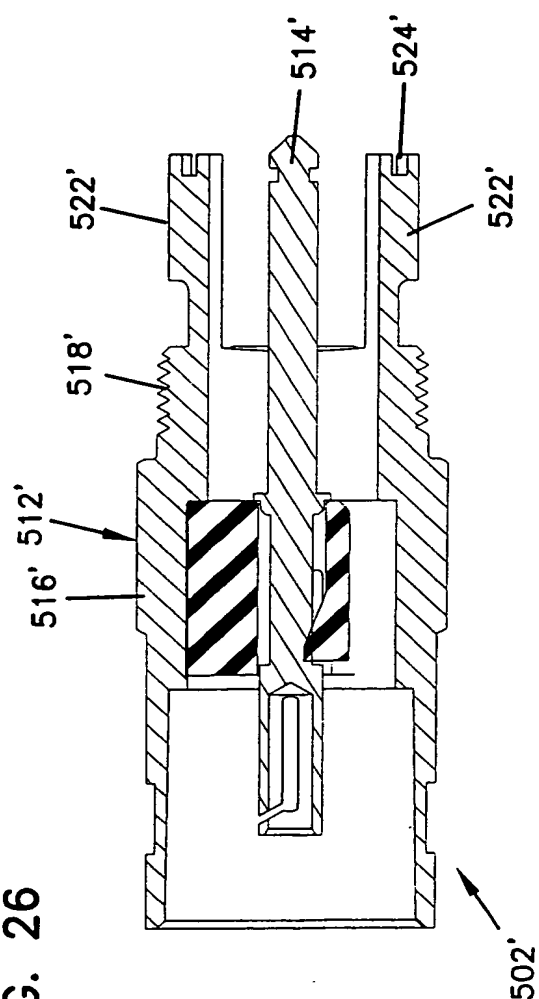


FIG. 26



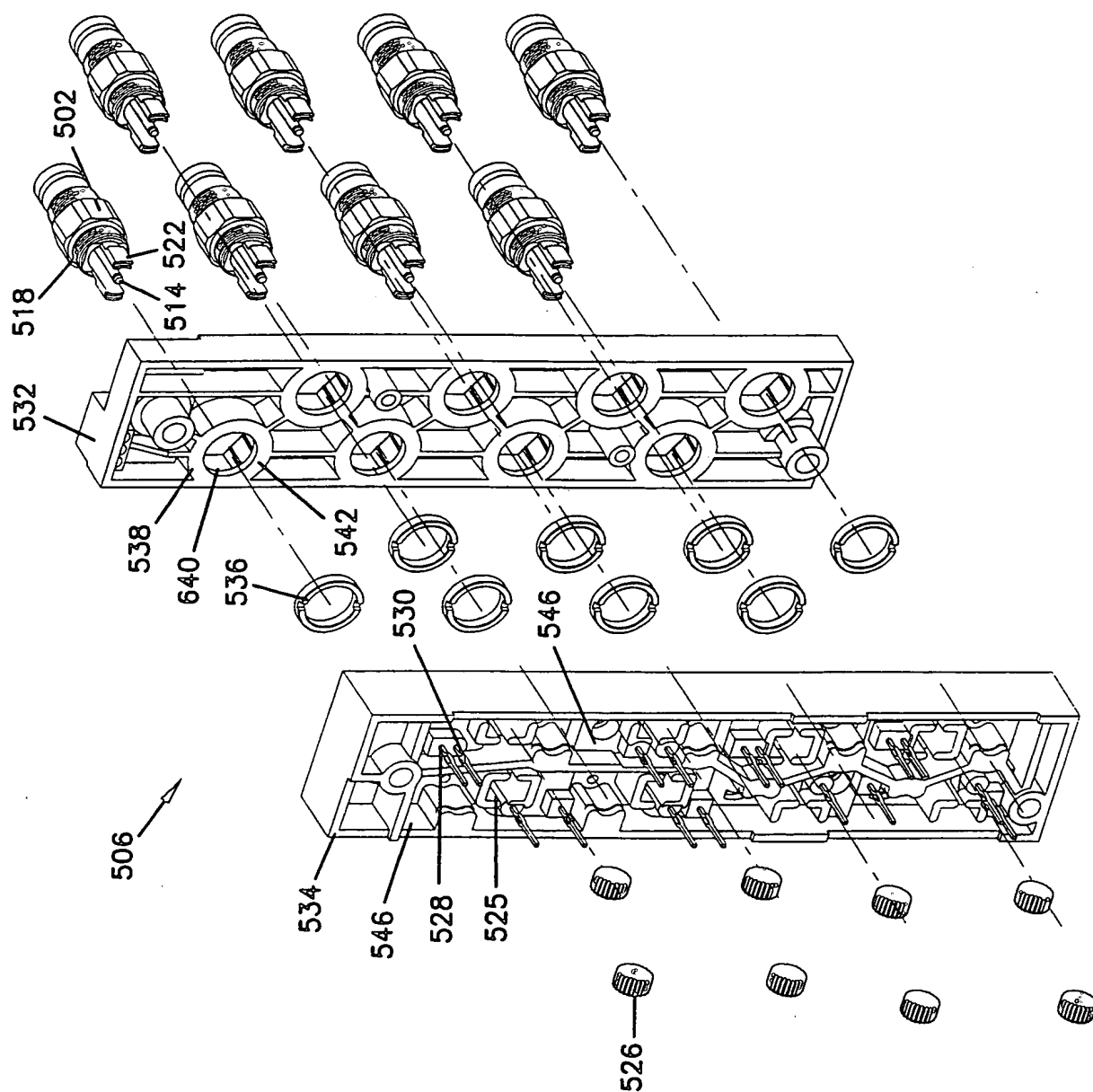


FIG. 27





# INTERNATIONAL SEARCH REPORT

International Application No

PC., US 99/26271

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H04Q1/14 H01R12/14 H01R13/00 H01R24/04

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H01R H04Q H05K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 96 38884 A (TELECT INC) 5 December 1996 (1996-12-05) the whole document	1-40, 43-45
X	US 4 969 258 A (FISHER JAMES ET AL) 13 November 1990 (1990-11-13) column 1, line 38 -column 2, line 10 column 3, line 53 -column 4, line 2; figures abstract	41,42
X	US 5 092 029 A (FISHER JAMES ET AL) 3 March 1992 (1992-03-03) column 5, line 20 -column 6, line 2; figures abstract	41,42

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

### \* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

Date of the actual completion of the international search

10 April 2001

Date of mailing of the international search report

04.05.01

Name and mailing address of the ISA

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Authorized officer

Kerstin Waczinska

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US99/26271

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: 1-40, 43-45 (all in part)  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:  
  
see extra sheet
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see extra sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

### Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☒ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (I)) (July 1998)

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US99/26271

## Continuation of Box I

The present application fails to comply with the clarity and conciseness requirements of Article 6 PCT to such an extent that a meaningful search on basis of the claims 1-40, 43-45 is impossible for the following reasons.

The description does not reveal which problem the invention relating to a jack assembly is intended to solve and consequently, there is no solution indicated. Claim 1 only contains an enumeration of a number of features relating to a jack assembly and to some extent the design of the features. Since it is difficult to determine the matter for which protection is sought, the search has been carried out for a jack assembly comprising the features mentioned in claim 1.

The novelty search done has revealed WO96/38884 A1 as representing particular relevant prior art useful for the understanding, searching and examination of the application. The document discloses the technical features stated in claim 1.

In view of this document the jack assembly mentioned in claim 1 lacks novelty. The independent claims 27, 35, 39, 40, 43 and 45 do not shear in common any special technical feature within the meaning of PCT Rule 13.2. Therefore, the requirement of unity of invention is not fulfilled considering claims 27, 35, 39, 40, 43 and 45. Furthermore, as far as the scope of the claims has been understood, at least what is claimed in claims 2, 3, 4, 6, 8, 9, 12, 20, 23, 24, 27, 35, 36, 37, 38, 45 does not comprise any technical features that defines a contribution over the prior art, i.e. is not new or inventive.

Therefore, claims 5, 7, 10, 13, 14, 15, 19, 21, 25, 28, 29, 30, 34 referring to claims 2, 3, 4, 6, 8, 9, 12, 20, 23, 24, 27, 35, 36, 37, 38, 45 will define a large number of inventions where non-unity *à posteriori* arises. If the requirement of unity of invention is fulfilled or not for each of these claims, cannot be determined with a reasonable effort due to the number of inventions. Neither would it be meaningful to require a large number of additional search fees.

Consequently, it is unduly burdensome to determine the matter for which protection is sought. The novelty search done is only considered to cover the features mentioned in claim 1.

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US99/26271

## Continuation of Box II

The International Searching Authority found multiple (groups of) inventions in this international application, as follows:

- I. Claims 1-40, 43-45 relate to a jack assembly, a jack, a jack mount or a jack mount assembly.
- II. Claims 41-42 relate to a method for mounting electrical connectors in a jack mount.

The "special technical features" of group I relate to a jack, while the "special technical features" of group II relate to a method for mounting electrical connectors in a jack mount. These two groups of inventions are not so linked as to form a single general inventive concept. There is no technical relationship among these inventions involving one or more of the same or corresponding technical features. Thus, the requirement of unity of invention according to Rule 13.1 PCT is not fulfilled.

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 99/26271

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
WO 9638884	A	05-12-1996	AU	2764695 A	18-12-1996
US 4969258	A	13-11-1990	CA	1323978 A	09-11-1993
US 5092029	A	03-03-1992	NONE		

Form PCT/ISA/210 (patent family annex) (July 1992)

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